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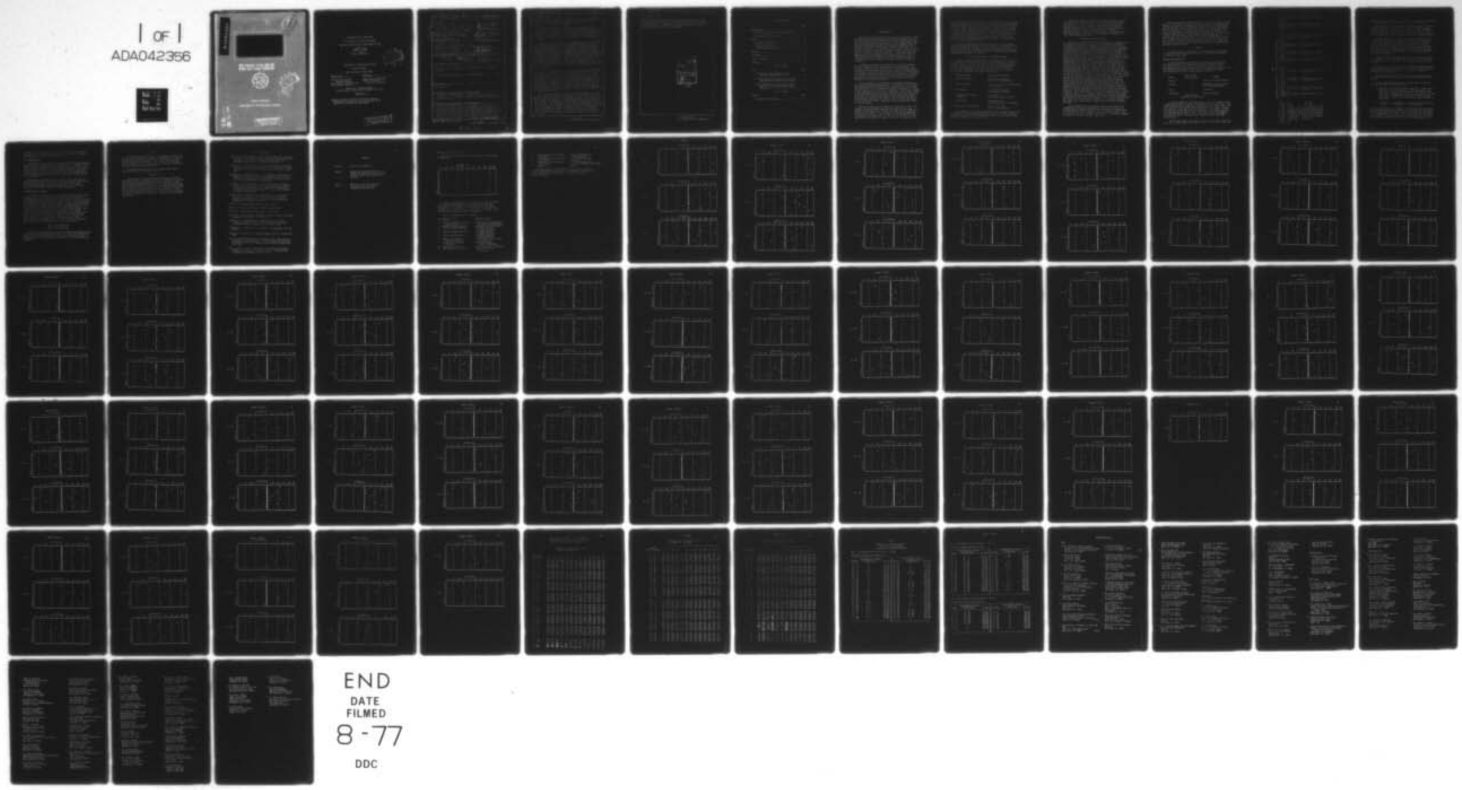

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PURDUE UNIVERSITY

DEPARTMENT OF PSYCHOLOGICAL SCIENCES

CLUSTER ANALYSIS OF JOBS BASED

ON A REVISED SET OF JOB DIMENSIONS

FROM THE POSITION ANALYSIS QUESTIONNAIRE (PAQ)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study deals with the cluster analysis of a sample of jobs based on data from the Position Analysis Questionnaire (PAQ). The PAQ is a structured job analysis questionnaire that provides for the analysis of various types of jobs in terms of 187 job elements of a "worker-oriented" nature. In carrying out this cluster analysis the intent was to derive clusters or job families that might be used in a later phase of the research program, in which the PAQ was to be used as the basis for the

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estimating
estimation of aptitude requirements for jobs. The clusters in question were to be based on scores in principal components resulting from a series of principal components analyses of PAQ data. The principal components are referred to as job dimensions.

The plans for the later phase provided for a comparison of the predictibility of aptitude requirements based on the PAQ when individual analyses of jobs are used as the basis for the predictions of the aptitude requirements, as contrasted with the circumstances in which individual jobs are first assigned to job families (using a D^2 index) and the aptitude requirements for those job families are then applied to the individual jobs so assigned.

A previous study involving the use of the PAQ in two cluster analyses of jobs had been carried out in which job dimension scores for jobs in the samples in question were also used as the basis for the cluster analyses. The job dimensions used in that study had been derived from an earlier series of principal components analyses of PAQ data. Since these two cluster analyses were carried out, however, data based on the PAQ have been subjected to another series of principal components analyses with the derivation of a new set of principal components. This newly developed set of job dimensions is considered to represent a somewhat more definitive reflection of the structure of jobs, and thus it is this set of job dimensions that will be used in the later phases of the current research program. Under the circumstances, a cluster analysis based on these new job dimensions was carried out. The study dealt with in this report is concerned with results of that cluster analysis.

The principal components analyses used in this study were those derived from the use of a sample of 2200 jobs. Those jobs were considered to be reasonably representative of jobs in the labor force in terms of major occupational groups. For the purpose of the cluster analysis a sample of about one third of those 2200 jobs was selected (746 to be exact); these jobs were generally those for which there were multiple analyses in the PAQ data bank. In the case of those jobs for which there were two or more analyses, the job dimension scores of all of those analyses included in that occupational category were averaged, and the average job dimension scores were used in the cluster analysis. In the case of jobs that were represented by only a single PAQ analysis, the job dimension scores for the individual jobs were used.

The cluster analysis was carried out with the hierarchical grouping technique developed by Ward (1961) and Ward and Hook (1963). The cluster analysis procedure involved is of an iterative nature. In this instance the procedure would consist of starting with 746 job groups, with one job in each group, continuing to the point at which all jobs would be within the same group. This procedure requires that a decision be made as to the number of clusters which would best serve the purposes in mind. Since there are no particularly satisfactory guidelines for use in selecting the iteration at which to stop (this decision in effect being one that determines the number of clusters to recognize), it was decided to select three stages in the iterative process, these being the ones at which

#3 - Abstract (Cont.)

60, 40, and 20 clusters were formed. This decision was made in order later to be able to compare the predicability of aptitude requirements of individual jobs as based on those for their job families, representing the three "levels" of homogeneity characterized by the three sets of clusters of 60, 40 and 20 jobs respectively.

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INTRODUCTION

Job classification systems have been around for many years, including those that have been developed and used by governmental agencies such as the Bureau of Census and the United States Employment Service, and those used by private organizations. In very general terms, most such systems have been developed on the basis of judgmental considerations, and probably represent what Theologus (1969) refers to as Linnaean taxonomies. Such taxonomies are predicated on the classification of individual entities of the generic type in question in terms of their "essence," or "essential nature." As Theologus points out, however, such classification systems suffer from the fact that they depend upon subjective judgments of a priori weights of various characteristics of the individual entities in formulating the classification system and in allocating individual entities to specific categories.

In general, he argues for a numerical classification approach, which has repeatability and objectivity as its cornerstones. The numerical taxonomists feel that classifications must be established on stable, objectively derived data bases, rather than on hypothesized relationships. One of the central axioms of numerical classifications is that the classifications be based on as many characters of features of the entities to be classified as possible; another axiom provides that each such character be given equal weight (to avoid injecting subjective bias into the structure).

Such an approach to classification is essentially polythetic in nature (as contrasted with monothetic). In monothetic classification the taxonomists defines each and every category in terms of a unique and usually small set of attributes such that the possession of these is both necessary and sufficient for membership in the group so defined. In turn, polythetic classification is based more on the overall pattern of the attributes which can be associated with individual cases to be classified. In discussing polythetic classification, Sokal (1974) makes the point that the "taxa" (that is, the individual entities to be classified) are groups of individual items or objects that share a large proportion of their properties, but do not necessarily agree on any one property.

While job classification systems have traditionally been of the armchair variety Thorndike some years ago (1953) did raise the question "Who belongs in the family?" as related to jobs, essentially arguing for the application of systematic procedures for answering the question he raised. In more recent years a combination of two circumstances has brought about at least a spate of activity in the application of systematic procedures to the classification of jobs.

One of these circumstances consisted of the development of structured job analysis procedures, such as task inventories (this technique having been developed primarily by the Air Force). These techniques provide for the analysis of jobs in terms of each of a number of "units" of job activities such as tasks. The other circumstance consisted of the development of methods of analysis which provide for the grouping of jobs into categories based on their patterns of similarities. In particular, the cluster analysis techniques have been used for the identification of categories of jobs with similar characteristics (Ward, 1961 and Ward and Hook, 1963). A bibliography of cluster analyses as related to jobs has been prepared by Farrell (1975).

The present report deals with the application of cluster analysis procedures to job data based on the Position Analysis Questionnaire (PAQ). Before discussing the relevance of cluster analysis to the research program of which this is a part, and the procedures used in the clustering aspect of the study, a brief description of the PAQ and certain other research relating to it will be given.

THE POSITION ANALYSIS QUESTIONNAIRE (PAQ)

The PAQ is a structured job analysis questionnaire that provides for the analysis of jobs in terms of each of 187 job elements of a "worker-oriented" nature. In effect, the job elements provide for the analysis of jobs in terms of elements that characterize basic human behaviors, or that imply such behaviors. The PAQ is divided into six divisions as listed below. For each of these divisions there is given an example of a PAQ job element that falls within the division.

	Division of PAQ	Examples of job elements
1.	Information Input	Use of written materials Near-visual differentiation
2.	Mental Processes	Level of reasoning in problem solving Coding/decoding
3.	Work Output	Use of keyboard devices Assembling/disassembling
4.	Relationships with Other Persons	Negotiating Job-related personal contact
5.	Job Context	High temperature Interpersonal conflict situations
6.	Other Job Characteristics	Specified work pace Amount of job structure

In the analysis of individual jobs with the PAQ the analyst uses a rating scale to rate the relevance of each job element to the job. Various rating scales are used with different job elements, such as extent of use, importance, amount of time, and so forth.

In previous research with the PAQ, principal components analyses have been carried out which resulted in the identification of what are referred to as job dimensions. Scores on these job dimensions have been used, in turn, as the basis for the estimation of the aptitude requirements of jobs, such aptitude requirements being expressed in terms of scores on the nine tests of the General Aptitude Test Battery (GATB) of the United States Employment Service. (McCormick, Jeanneret, and Mecham, 1972; Marquardt and McCormick, July, 1974; Mecham, April 1977).

BACKGROUND FOR PRESENT STUDY

The present research program consists primarily of an extension of the previous research with the PAQ for the estimation of aptitude requirements of jobs, but is concerned with the use of test data for incumbents based largely on commercially-available tests, as contrasted with the GATB tests. In this regard, two approaches to the prediction of such aptitude requirements are to be carried out, one of these involving the use of PAQ analyses of individual jobs as the basis for prediction, and the other consisting of the use of job families as the basis for such predictions. It is in the second regard that the cluster analysis described in this report is relevant. In particular, it is planned that the jobs that will be involved in the study will be categorized by job families, and that estimated aptitude requirements for each job family would then be applied to the individual jobs covered by the study that fall within each such job family. It would then be possible to compare the "effectiveness" of estimates of the aptitude requirements of jobs as based on these two approaches—one in which the PAQ analysis of individual jobs is used as the basis for such estimates, the other consisting of a set of aptitude requirements derived for the job famililies into which the individual jobs fall. Two cluster analyses of jobs based on data from the PAQ have been carried out (De Nisi and McCormick, September 1974). One of these involved the hierarchical grouping technique developed by Ward (1961,) and the other involved the BC—TRY procedure (Tryon and Bailey, 1970). These analyses were based on job dimensions resulting from the principal components analyses carried out by Marquardt and McCormick (June 1974). One of the principal components analyses was an "overall" or "general" analysis, in which 168 elements of the PAQ were pooled together. This resulted in the identification of 14 principal components of an "overall" or general nature. These dimensions were used in the BC—TRY program. In addition, Marquardt and McCormick carried out principal components analyses of the job elements within each of the six divisions of the PAQ. This resulted in 30 "divisional" components. 21 of these components were used in the cluster analysis based on the hierarchical grouping technique.

In very general terms, the clusters resulting from the BC—TRY procedure were somewhat more homogeneous than those resulting from the hierarchical grouping technique. This difference, of course, might be attributable to various factors, such as the methods used, or the nature of the principal components used (that is, the difference between the "overall" and the "divisional" dimensions).

More recently, Mecham (February 1977) has carried out a series of somewhat similar principal components analyses of a sample of 2,200 jobs that probably are somewhat more representative of the jobs in the labor market than the previous principal components analyses. This study resulted in the identification of 13 "overall" dimensions, and 30 "divisional" dimensions. A comparison of the dimensions resulting from the study by Marquardt and McCormick and that of Mecham revealed substantial similarity in many of the dimensions, although there were a few dimensions in each set which were somewhat unique. In certain instances these seem to reflect subdivisions of individual dimensions from the other study. However, certain of the dimensions reported by Mecham seem to be somewhat more clear cut in that there were more job elements with reasonably high loadings on those dimensions.

METHOD

The study consisted essentially of a cluster analysis of a sample of jobs, the clustering being based on the use of job dimension scores for the jobs in the sample.

Selection of Sample Jobs

In selecting jobs to be included in the cluster analysis it was the intent to select jobs that would be reasonably representative of the proportions of jobs in various occupational categories. Data from the Dictionary of Occupational Titles (DOT) were used as the basis for the selection of the sample. In this regard, the DOT provides for the categorizing of jobs at various levels, as follows:

Level	No. of digits used in coding	Example
Category	1	Clerical and sales occupations
Division	2	Stenography, typing, filing and related occupations
Group	3	Secretaries
Occupations	9 (the last three digits are "suffix" codes)	Medical secretary

In the development of the sampling base, it was the intent to select a sample that would be reasonably representative of the proportions of job classifications within "categories" represented by the 1-digit codes. However, certain "sub-categories" were recognized for this purpose, because of differences in the jobs within the categories. For example, clerical jobs were considered separately from sales jobs. These "sub-categories" are identified at the 2-digit level. The categories and sub-categories are listed in Table 1, along with the 1-digit or 2-digit codes that identify them.

Within these classes there were two levels that could be used as the basis for deriving numbers and percents of job classifications, namely the

Table 1

Data Used in the Selection of Sample of Jobs for Cluster Analysis

Sampling units in terms of 2-digit divisions	Number of classifications in DOT				Number in PAQ data bank				Sample selected by 3-digit group	
	3-digit group		9-digit occupations		3-digit group		9-digit occupations			
	No.	%	No.	%	No.	%	No.	%	No.	%
00-15+19 Professional	81	13.5	1212	8.7	55	15.0	234	15.7	108	14.5
16-18 Managerial	19	3.2	535	3.8	18	5.0	141	9.5	38	5.1
20-24 Clerical	37	6.2	720	5.2	36	10.0	254	17.1	62	8.3
25-29 Sales	45	7.5	265	1.9	15	4.0	27	1.8	27	3.6
30-36+38 Service	59	9.8	431	3.1	25	7.0	36	2.4	36	4.3
37 Protective service	8	1.3	99	.7	6	2.0	44	3.0	16	2.1
40-49 Farming	34	5.7	301	2.2	12	3.0	18	1.2	18	2.4
50-59 Processing	69	11.4	3190	22.9	40	11.0	127	8.5	90	12.1
60-69 Machine trades	78	13.0	2220	15.9	56	15.0	221	114.9	106	14.2
70-79 Benchwork	72	12.9	2793	20.1	33	9.0	126	8.5	106	14.2
80-89 Structual work	48	8.0	1012	7.3	35	10.0	146	9.8	66	8.8
90-91 Transportation	14	2.3	245	.5	12	3.0	32	2.2	23	3.1
92 Packaging	4	.7	335	2.4	4	1.1	30	2.0	12	1.6
93 Extraction	6	1.0	123	.9	2	.5	2	.1	3	.4
94 Logging	4	.7	61	.4	3	.8	4	.3	4	.5
95 Utilities	9	1.5	141	1.0	8	2.2	38	2.6	18	2.4
96 Amusement	6	1.0	70	.5	2	.5	2	.1	2	.3
97 Graphic arts	9	1.5	70	1.2	5	1.4	5	.3	11	1.5

3-digit job groups and the 9-digit occupations. The numbers and percents of classifications at these two levels are also given in Table 1.

Another step in the selection of the sample consisted of taking an inventory of the job classifications for which PAQs were available in the PAQ data bank of about 25,000 PAQ analyses. These 25,000 PAQ analyses represented about 1900 9-digit code classifications. The numbers and percents of these in terms of the classification categories at the 3-digit level and at the 9-digit level are also shown in Table 1.

In examining the data in Table 1 a decision was made to use the percents of 3-digit classifications as the basis for selecting the sample. This decision was based upon the following considerations: (1) the fact that the percent of 9-digit jobs within the 2-digit divisions in the DOT appeared to over-represent certain of the major job categories, and (2) it was determined that it would be possible to match the 3-digit percentages better than the 9-digit percentages, given the number and DOT classification of the jobs for which PAQ analyses were available.

A sample of 746 (out of about 1900) 9-digit jobs were selected so as to match as closely as possible the percentages of 3-digit groups in each of the 2-digit divisions. The following selection procedure was used:

(1) For each 2-digit division the "population" percentage within that division was multiplied by 746 to determine the number of 9-digit classifications that would be needed to represent the population percentage in a sample of 746.

(2) The list of 1900 9-digit jobs was then grouped according to (a) the 2-digit codes, and (b) the 3-digit codes within each 2-digit division.

(3) For each 2-digit division the required number of jobs was selected using the following guidelines:

(a) Select at least one job for each 3-digit code in the division. For each 3-digit code, the jobs selected were the ones for which there were the largest numbers of PAQ analyses available. It was thought this practice would provide, in the long run, a more representative sample of jobs, than a sample consisting largely of jobs for which only single PAQs were in the data bank.

(b) If additional jobs needed to be selected, they were selected randomly from the remaining jobs in the division.

It should be noted that, for some of the 2-digit divisions, the number of 9-digit jobs for which PAQ analyses were available was less than the number "required" for the 746 job sample. In such cases, all 9-digit jobs were selected for the sample. In those divisions for which there was a "surplus" of 9-digit jobs available, extra jobs, over the number required, were selected so as to build up the total sample size to

a total of 746 for the cluster analysis. Table 1 shows the number and percent of job classifications in the sample for the basic categories and sub-categories given in that table.

Job Dimensions Used

As indicated earlier, Mecham's dimensions probably represent the most adequate "structure" of jobs as based on PAQ data. It is expected that they will be used operationally in the further use of the PAQ. In view of this, the cluster analysis was based on these dimensions. The resulting clusters were to be used in a later phase of the research program for making a comparison of the predictability of aptitude requirements from individual PAQ analyses as contrasted with those based on job families (i.e., clusters).

This analysis was based on the 13 "overall" dimensions, this determination being made in part on the belief that certain of the differences in the homogenity of job families reported by De Nisi and McCormick may have been attributable to the types of job dimensions used (i.e., the "overall" versus "divisional" dimensions).

Cluster Analysis Procedure

The cluster analysis was carried out using the hierarchical grouping technique, with one modification. That modification consisted of a differential weighting of the job elements in terms of their statistically-derived contribution to the dimensions. Mecham (1976) reports that in the application of this modification as applied to job data within individual organizations, the resulting clusters seem to be somewhat more definitive and clear-cut than without this differential weighting procedure. In connection with the use of job families for predicting aptitude requirements of jobs, one possible problem is determining the "optimal" number of job families to use in the prediction. In this regard, since there was no relevant guideline available for determining the number of job families to use, a decision was made to use the job families that emerged at three stages of the iteration process following the hierarchical clustering procedure. The three stages selected were those resulting in the following three sets of job families.

Set A: 60 job families
Set B: 40 job families
Set C: 20 job families

For each of the families within each set average job dimension scores were derived for the jobs within the family. In turn, the job dimension scores were converted into percentiles based on the original sample of 2200 jobs used in the principal components analyses for deriving the job dimensions.

RESULTS

The profiles of the job families represented by the percentile values of the 13 dimensions are given in the Appendix. In addition, the mean job dimension scores and their standard deviations are given in Table 2 in the Appendix. Table 3, also in the Appendix, includes the mean for all of the job families for each of the three sets, and for each separate job family.

It should be added that certain job families retain their identities in two, or all three, of the sets.

DISCUSSION

Three sets of clusters were developed from a sample of 746 jobs based upon the job dimension scores of 13 overall job dimensions derived from data from the Position Analysis Questionnaire (PAQ). These three sets were developed for use in a later study (McCormick, DeNisi, and Shaw, May 1977) as the basis for predicting the aptitude requirements of a sample of jobs for which validity and/or normative data on commercially available tests had been collected. In the later study a comparison was to be made of the relative effectiveness of each of the three sets of clusters for predicting such aptitude requirements.

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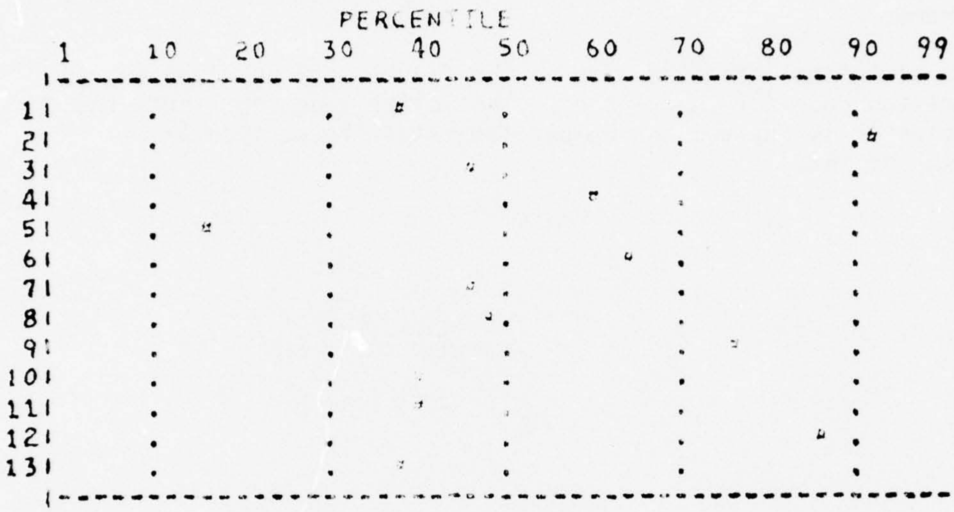
APPENDIX

Figure 1. Profile of Job Clusters

The profile for each of the job clusters will be given in the following form:



Along the left-hand side of the figure are listed the numbers 1-13. These numbers represent the 13 overall job dimensions resulting from the principal components analysis of 2200 jobs. For each of the 13 dimensions the # sign represents the percentile value of the job dimension score of the jobs in the cluster. These percentiles were based on a sample of 2200 jobs.

The 13 job dimensions are as follows:

No.	Technical Title	Operational Title
1.	Decision/communications/general responsibilities	Having decision, communicating and general responsibilities
2.	Machine/equipment operation	Operating machines/equipment
3.	Clerical/related activities	Performing clerical/ related activities
4.	Technical/related activities	Performing technical/ related activities
5.	Service/related activities	Performing service/ related activities
6.	Regular day schedule vs. other work schedules	Working regular day vs. other work schedules
7.	Routine/repetitive work activities	Performing routine/ repetitive activities
8.	Environmental awareness	Being aware of work environment
9.	General physical activities	Engaging in physical activities

10.	Supervising/coordinating other personnel	Supervising/coordinating other personnel
11.	Public/customer/related contact activities	Public/customer/related contacts
12.	Unpleasant/hazardous/demanding environment	Working in an unpleasant/hazardous/demanding environment
13.	Unnamed	Unnamed

Also along the left hand side of the figure will be given an identification code for the cluster. The letter code represents the set the cluster is in, and the number indicates the particular cluster in the set.

Figure 1 (Cont.)

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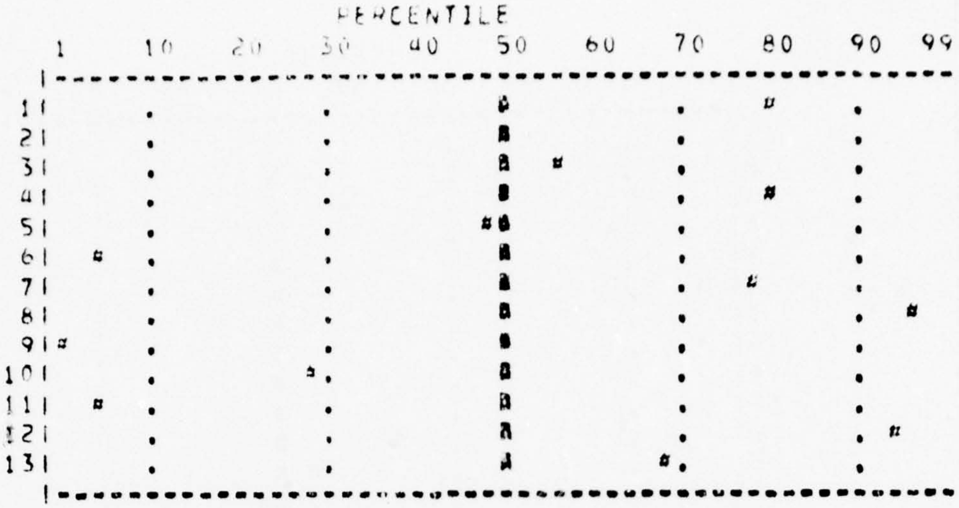

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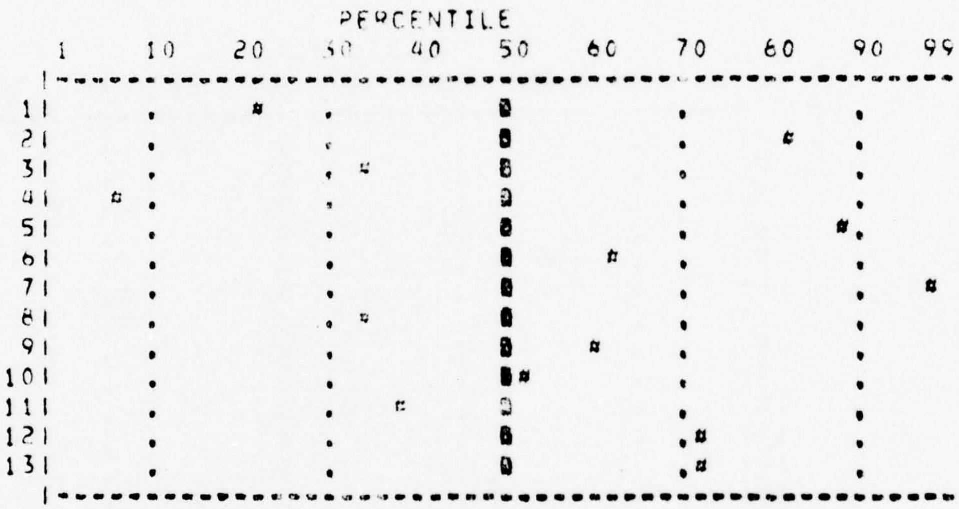

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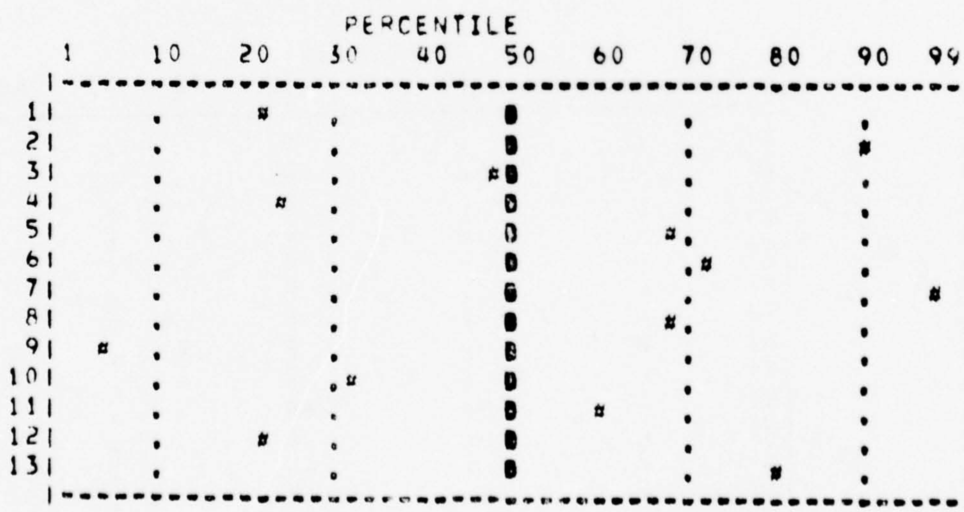

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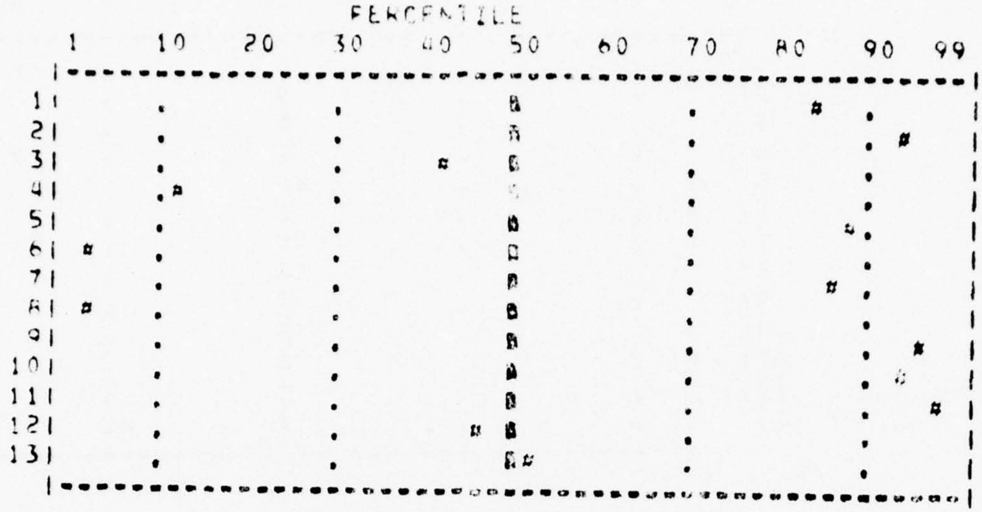

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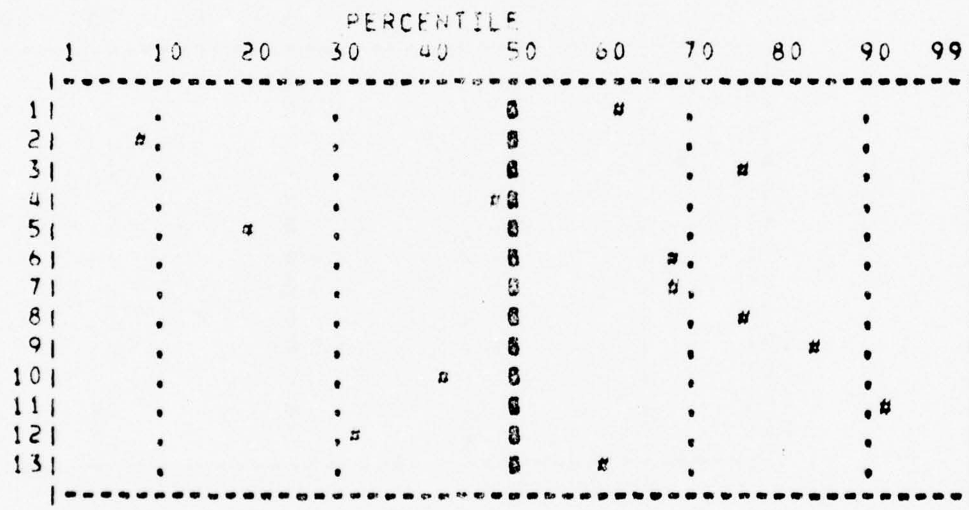

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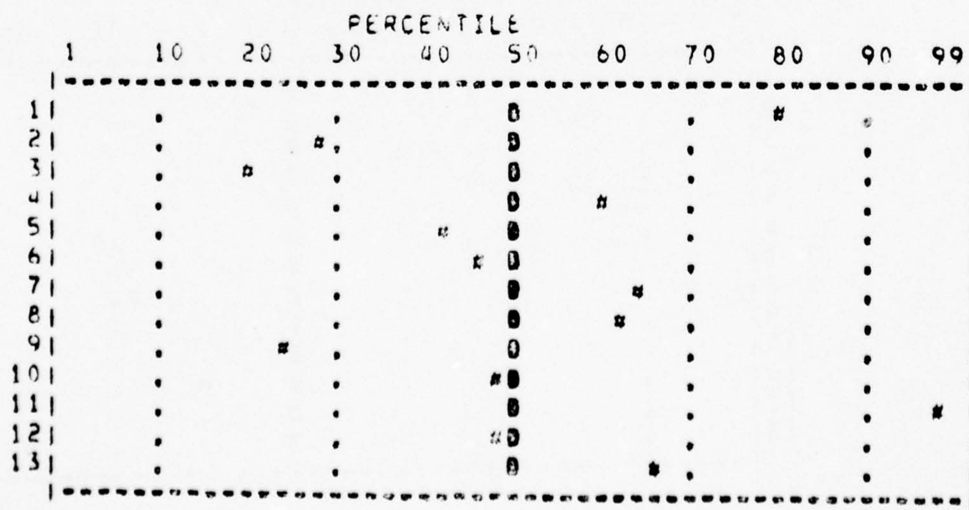

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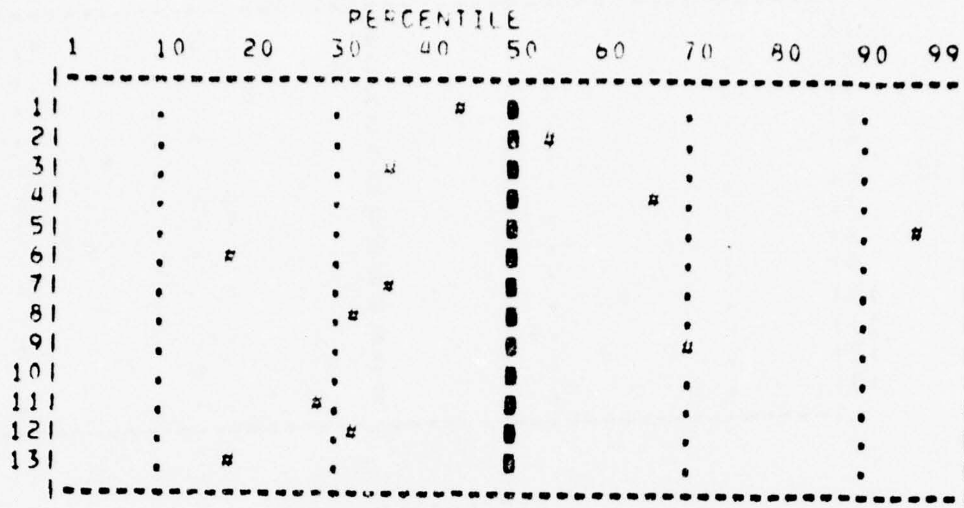

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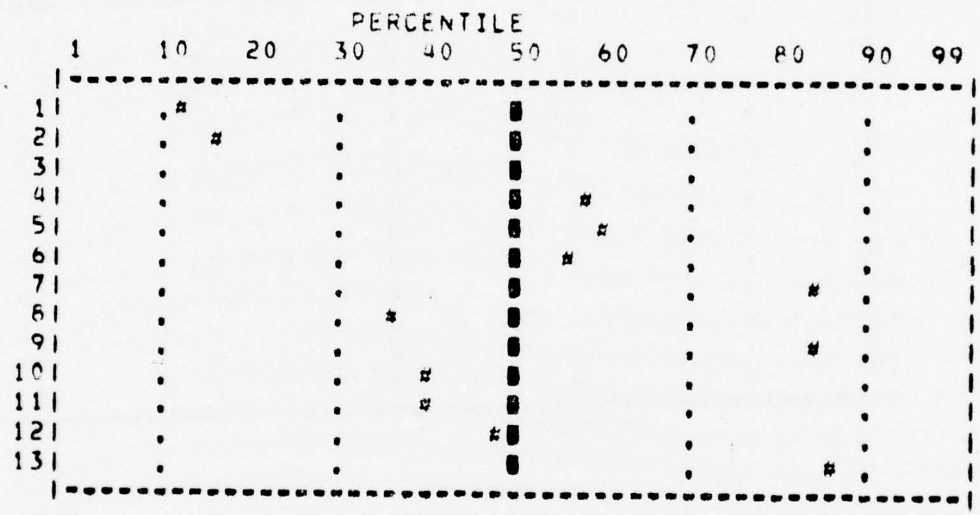
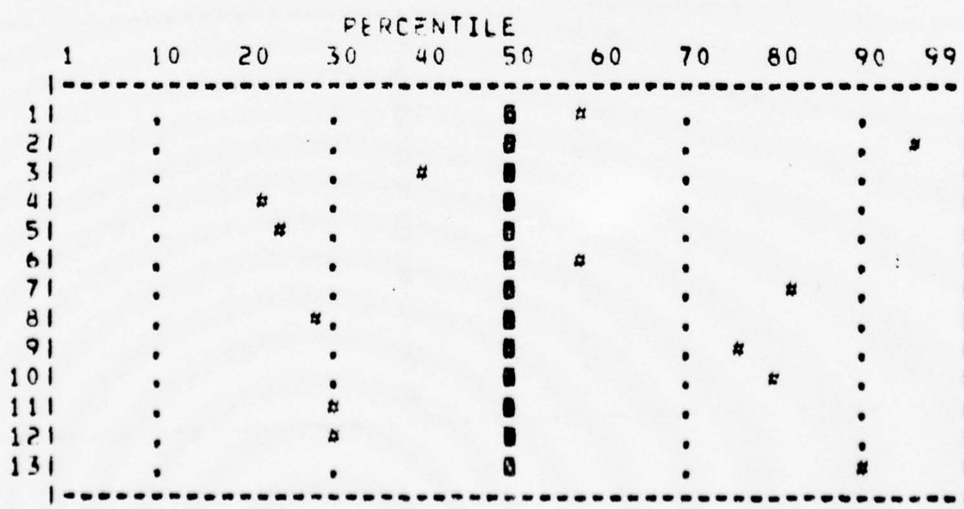
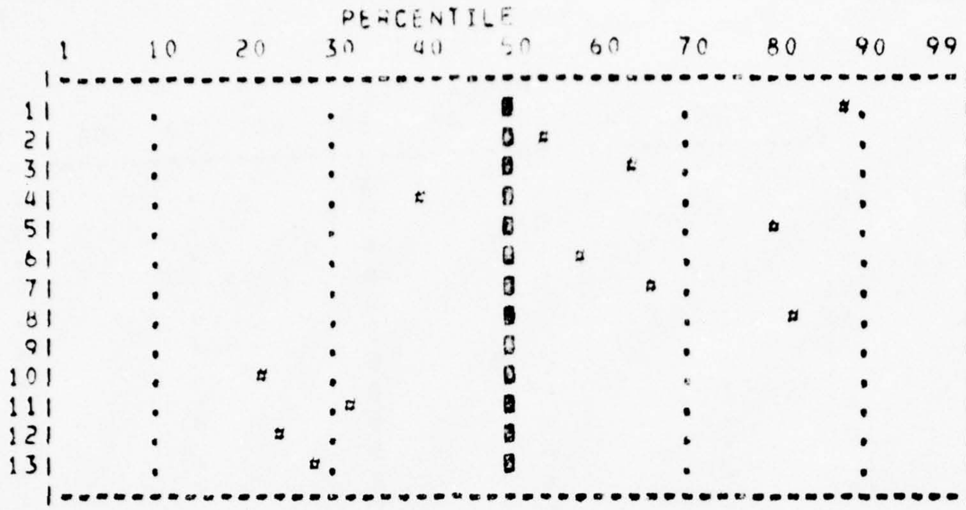


A - 9



A - 10


PERCENTILE
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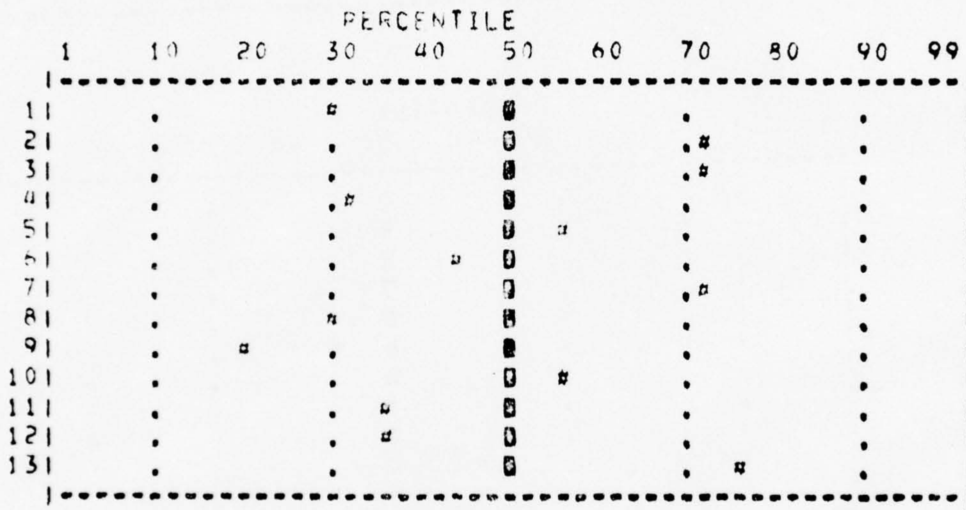
A - 11


PERCENTILE
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A - 12

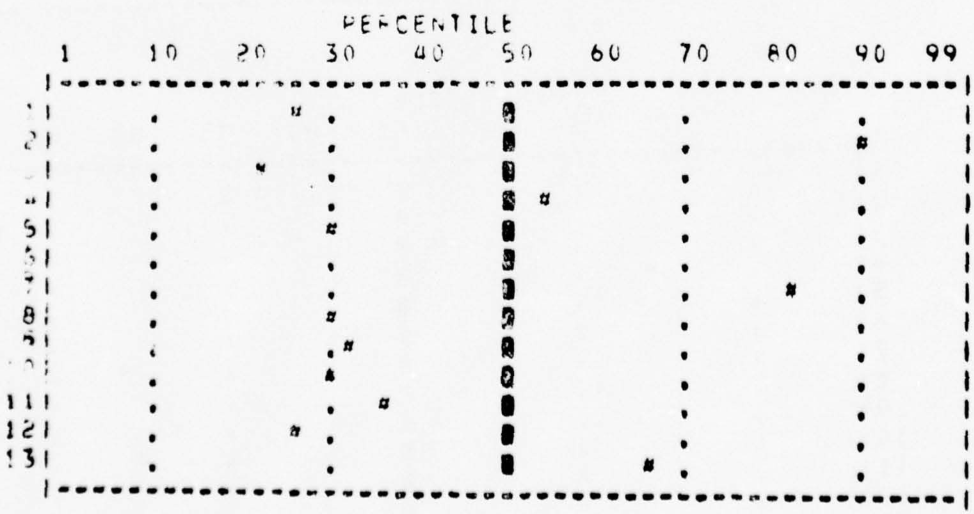
PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
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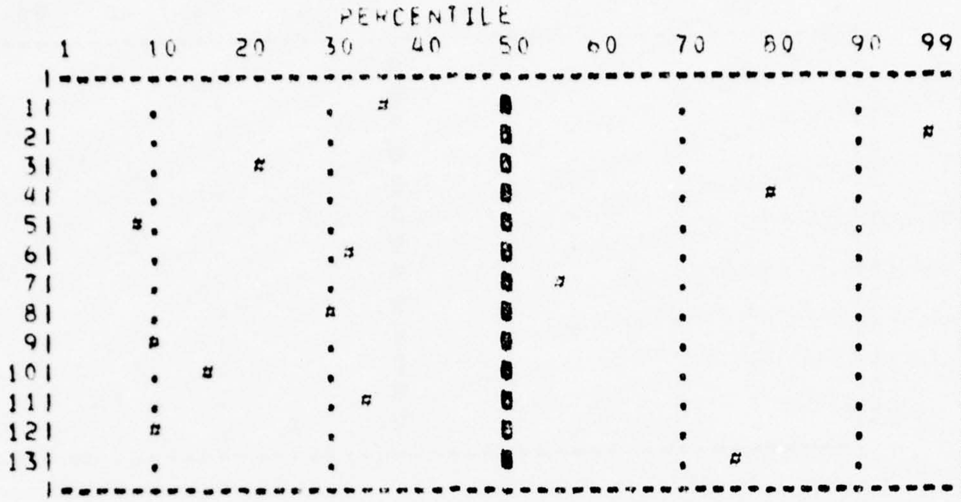
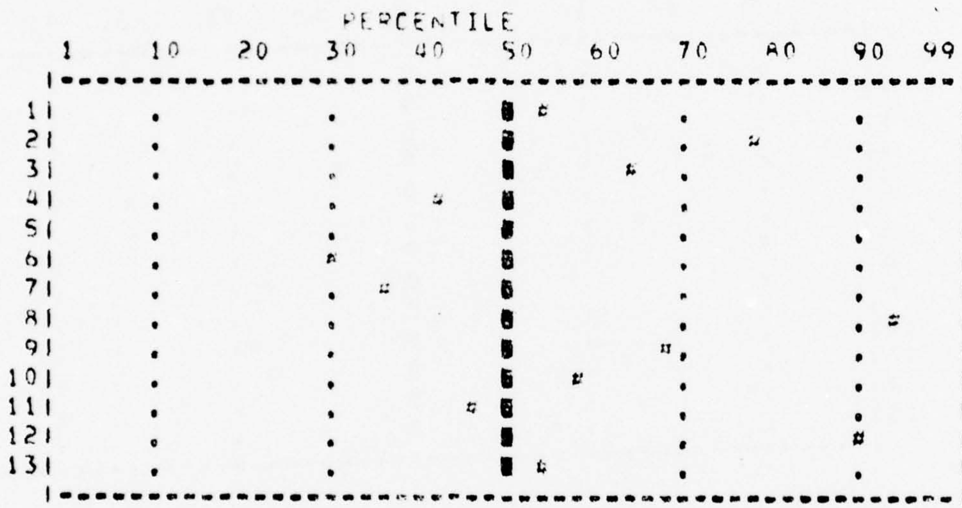
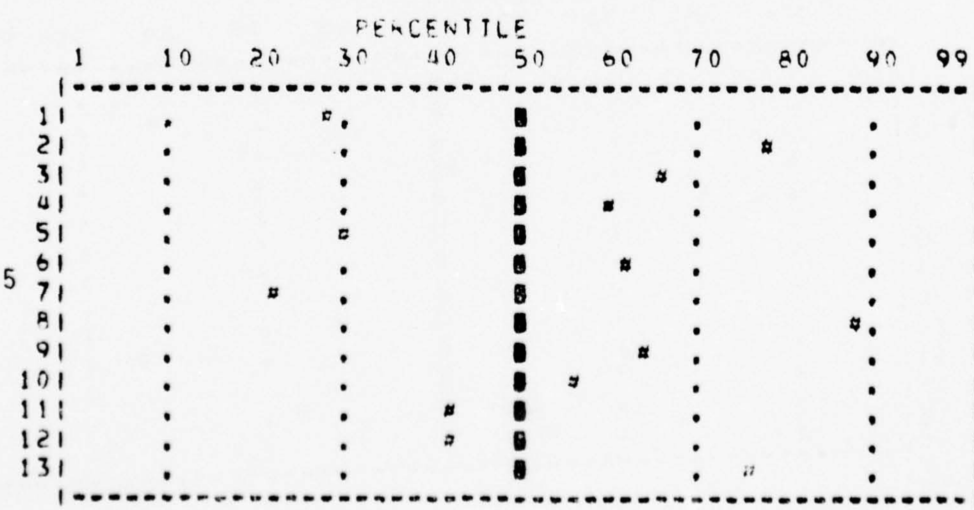
Figure 1 (Cont.)



A - 13



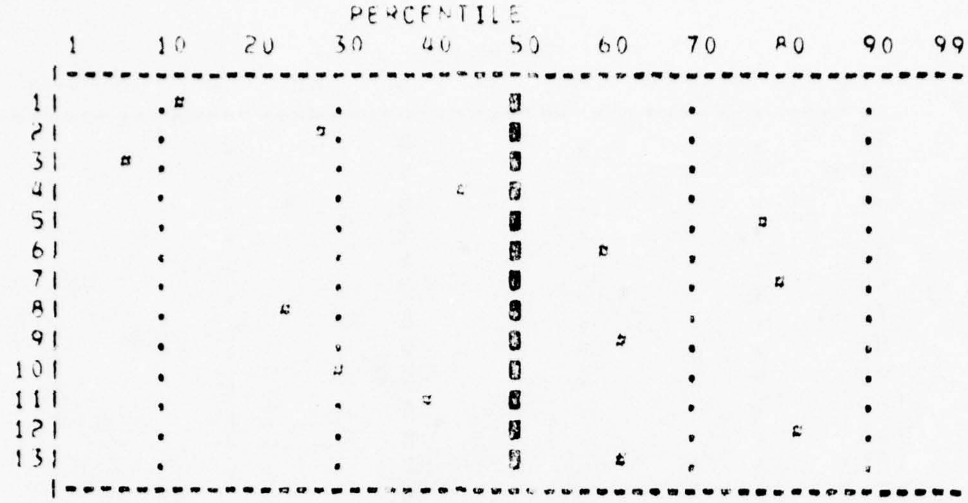
A - 14



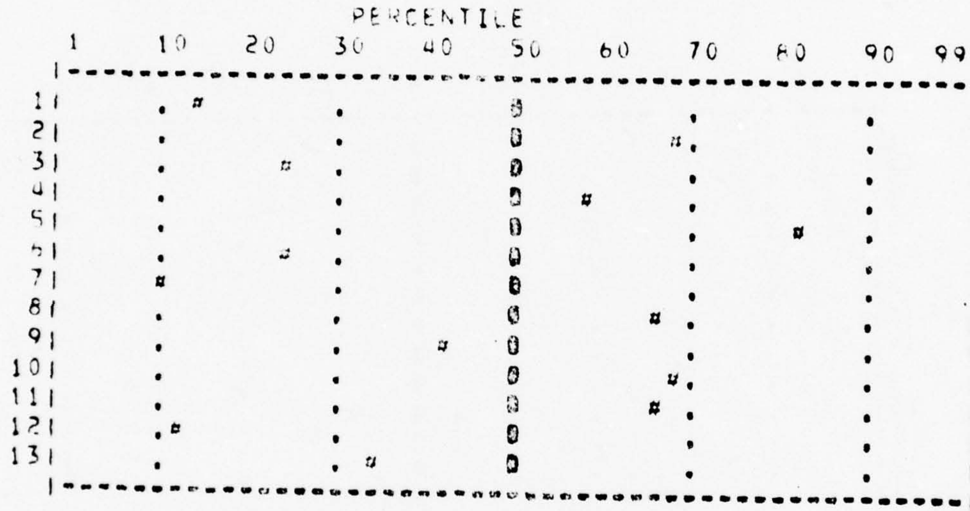
A - 15

Figure 1 (Cont.)

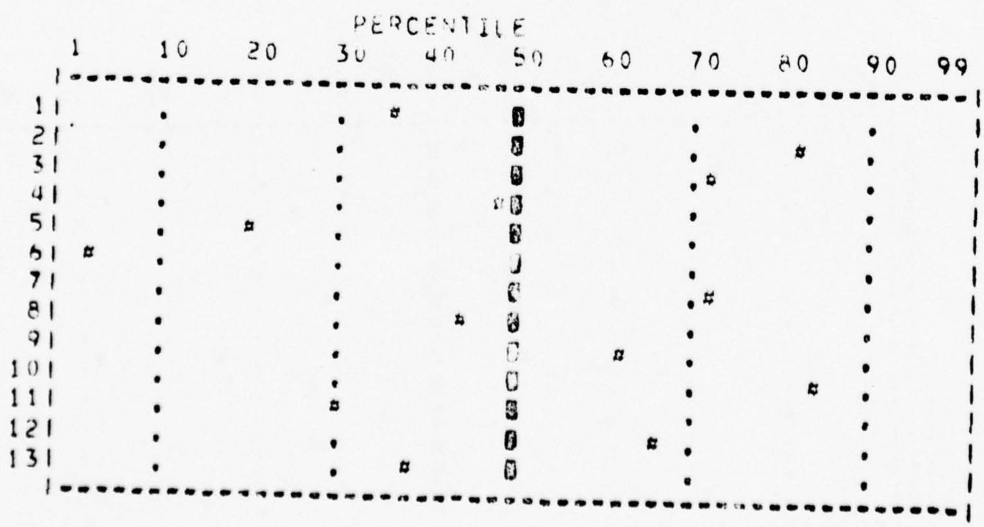
A - 16

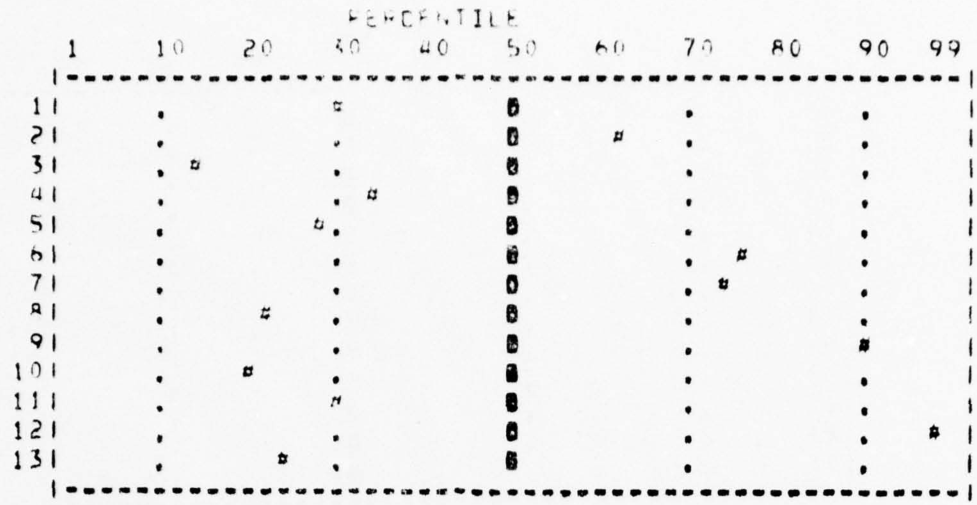


A - 17



A - 18




PERCENTILE
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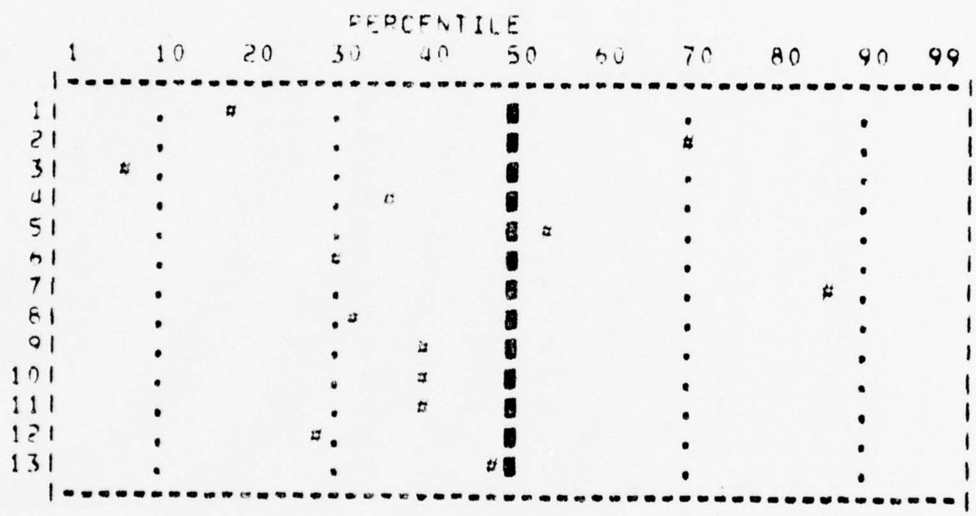
A - 19


PERCENTILE
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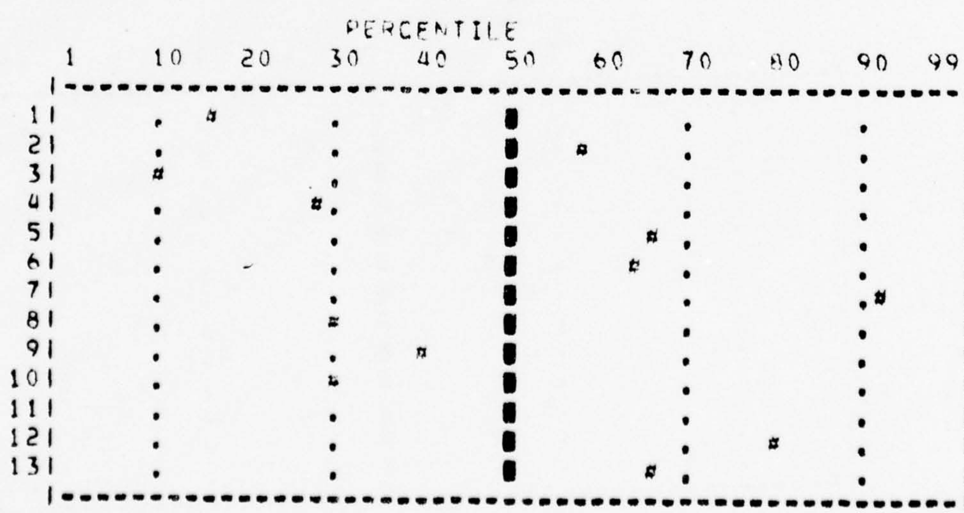
A - 20


PERCENTILE
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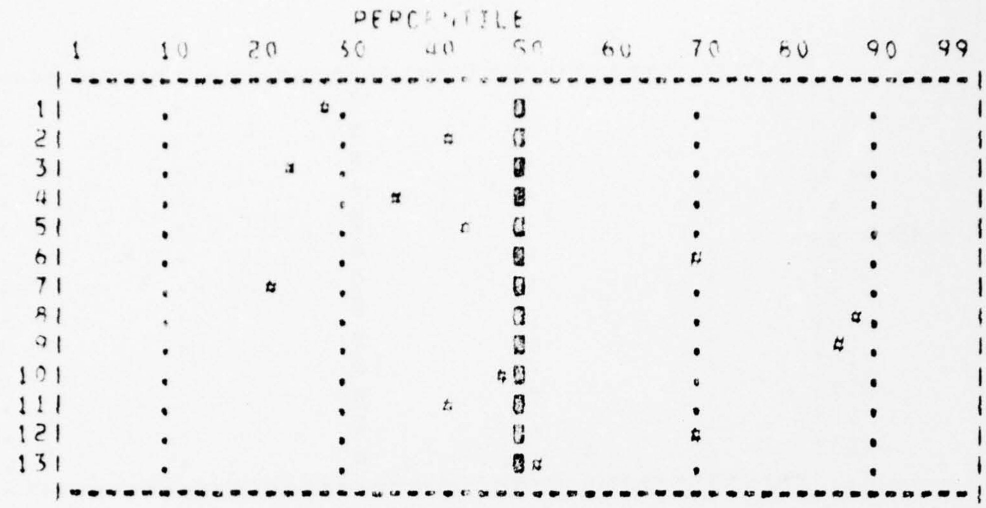
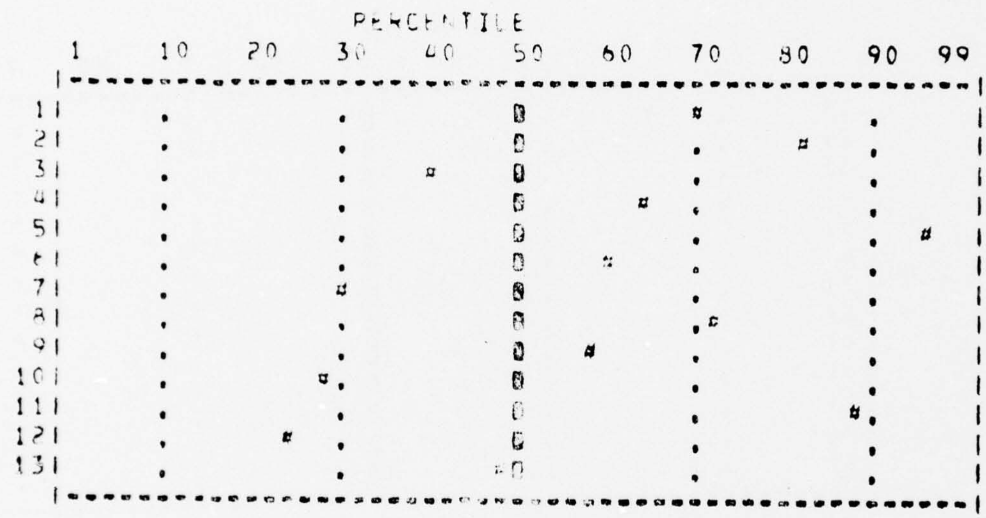
A - 21

Figure 1 (Cont.)

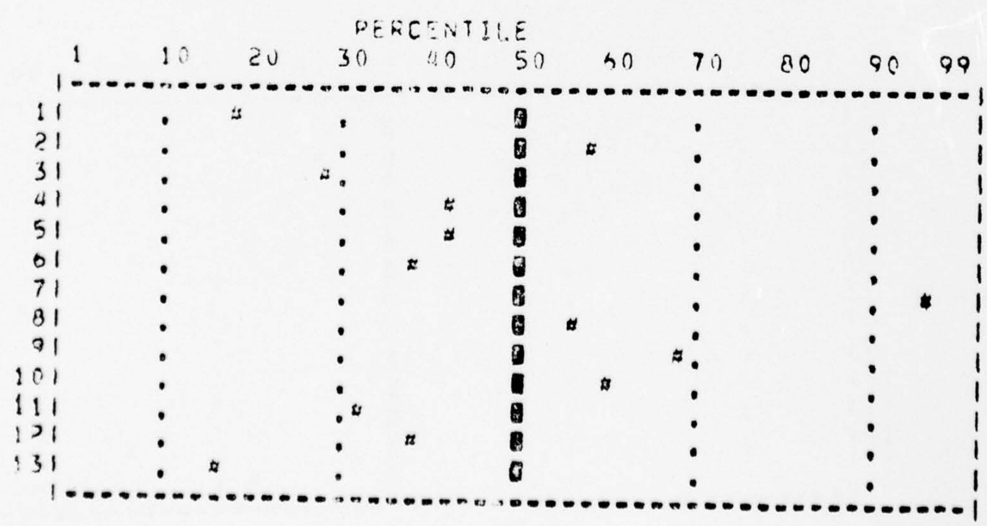
A - 22



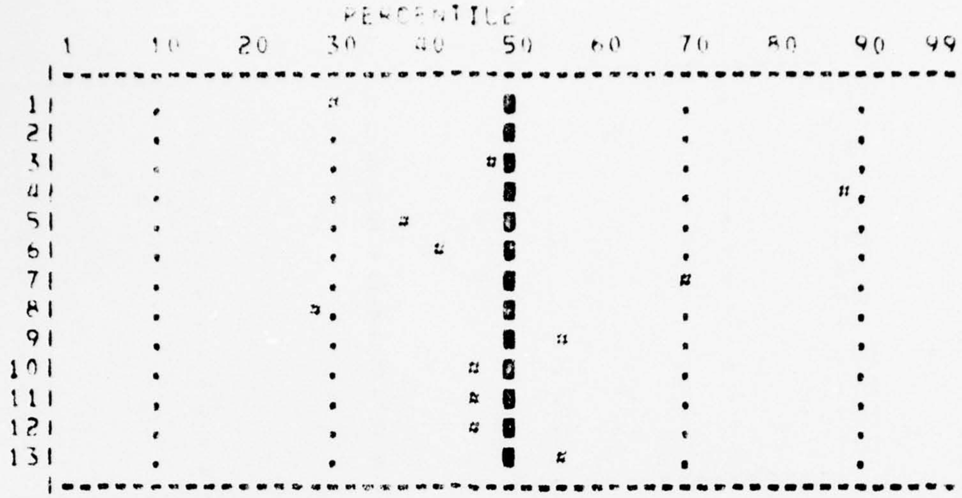
A - 23



A - 24



A - 25


PERCENTILE
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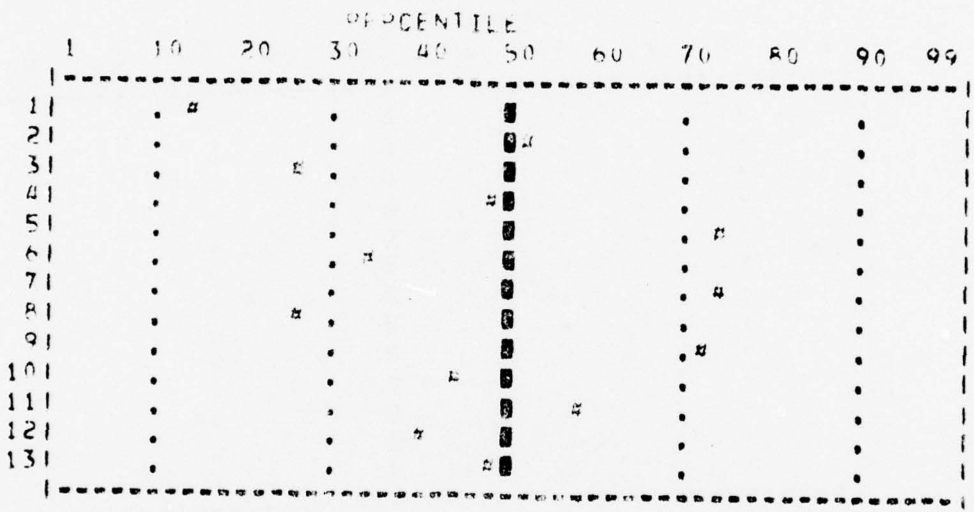
A - 26


PERCENTILE
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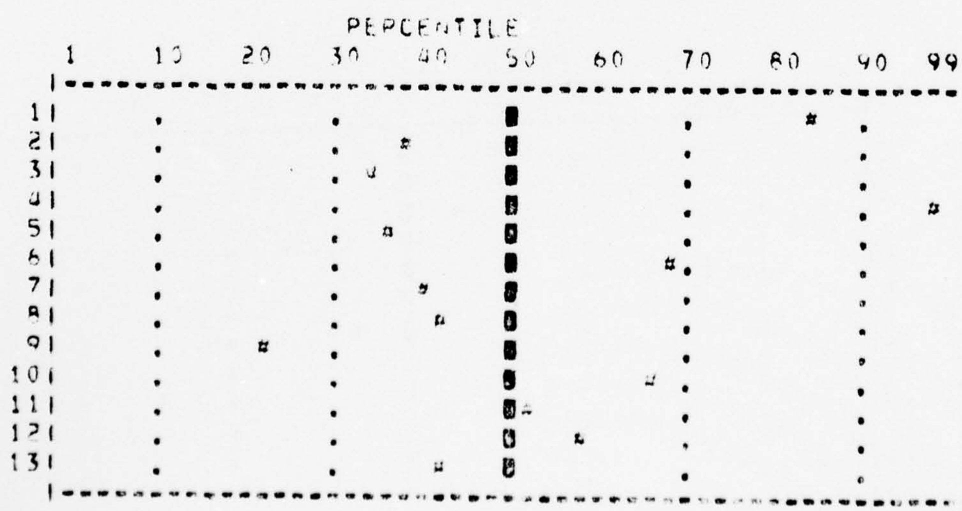
A - 27


PERCENTILE
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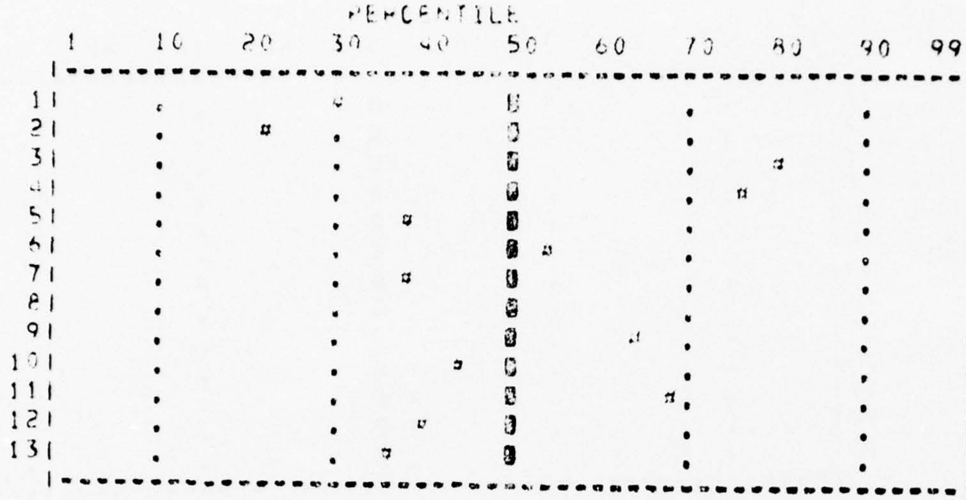
A - 28


PERCENTILE
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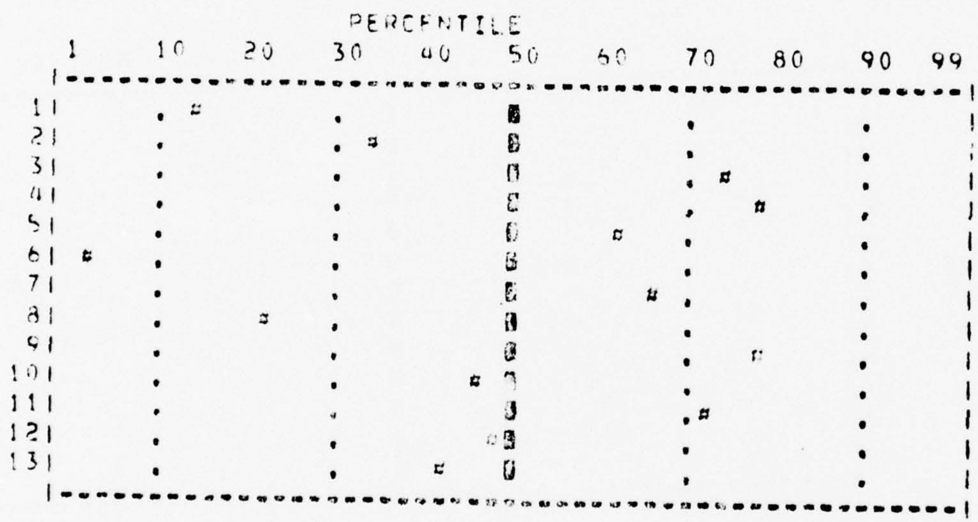
A - 29


PERCENTILE
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A - 30

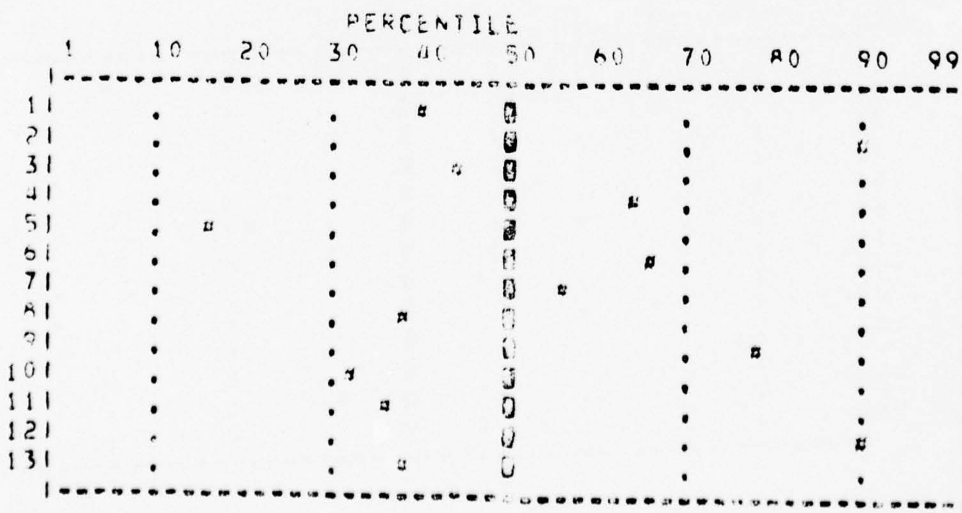
PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
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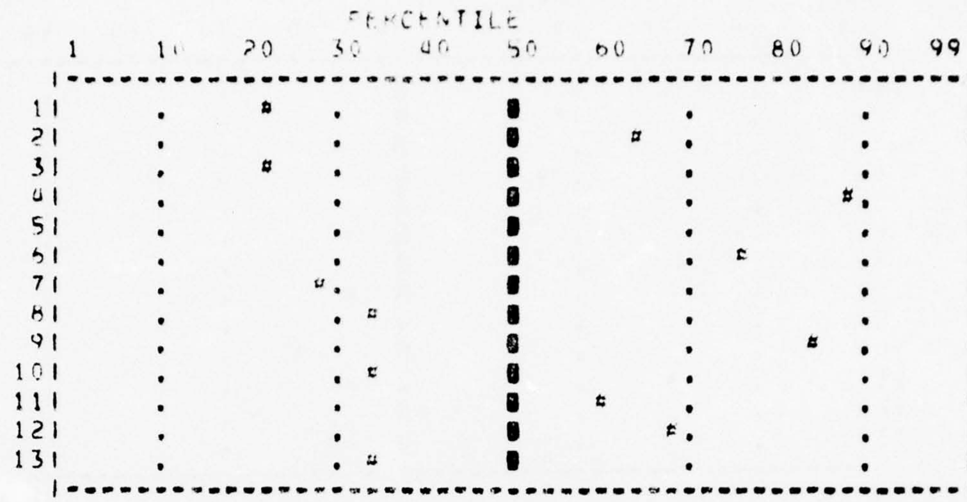
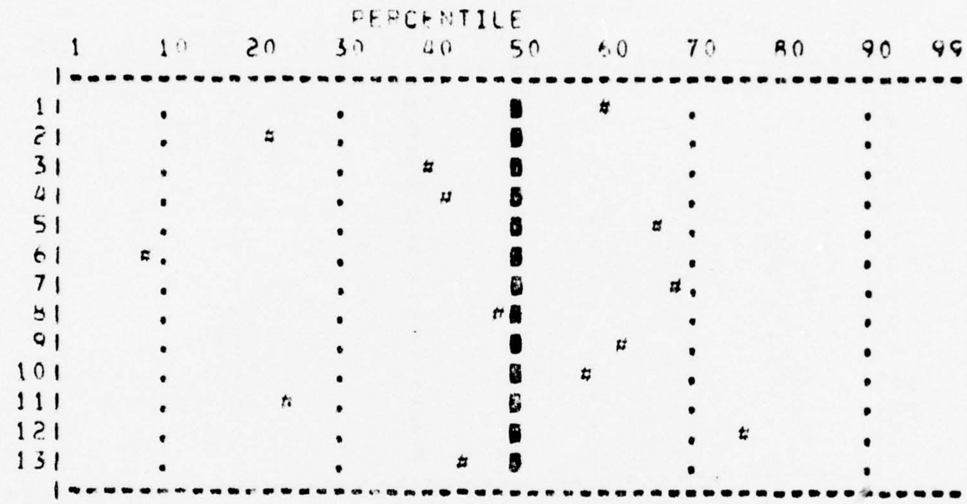
Figure 1 (Cont.)

A - 31



A - 32



A - 33

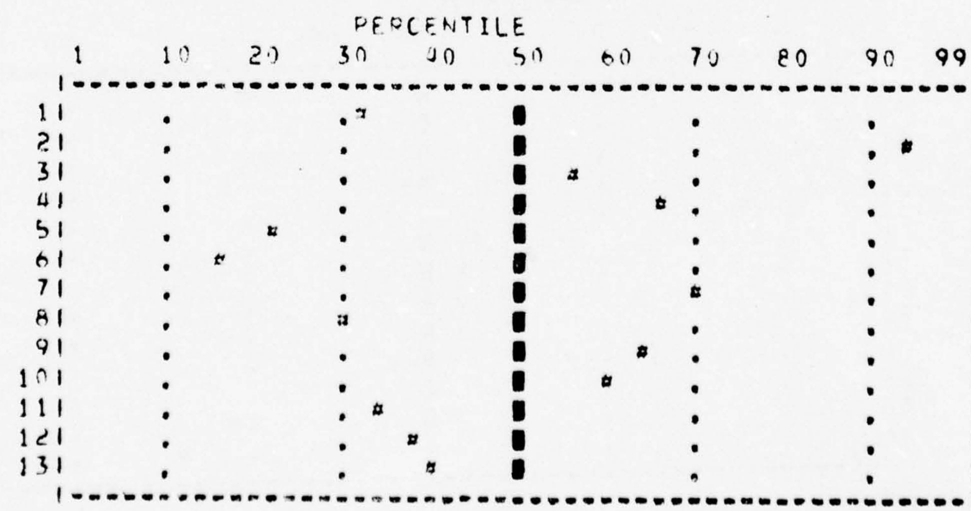
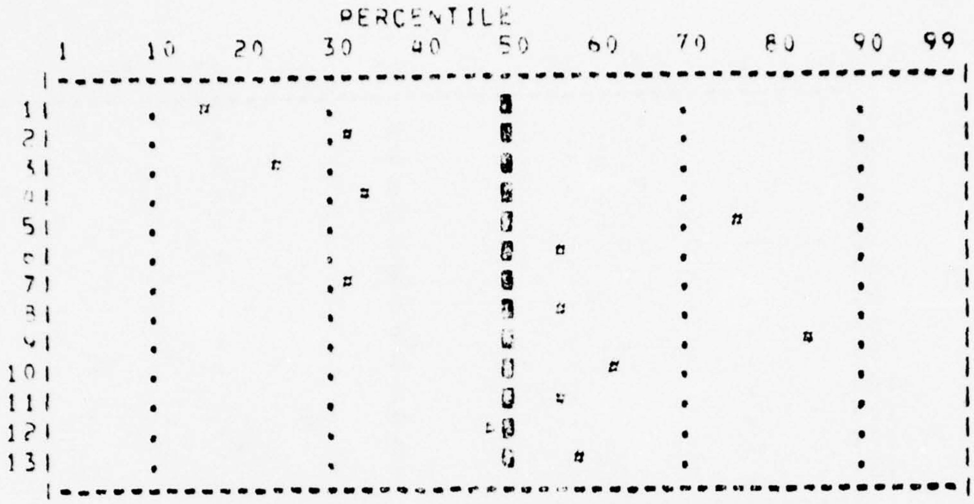
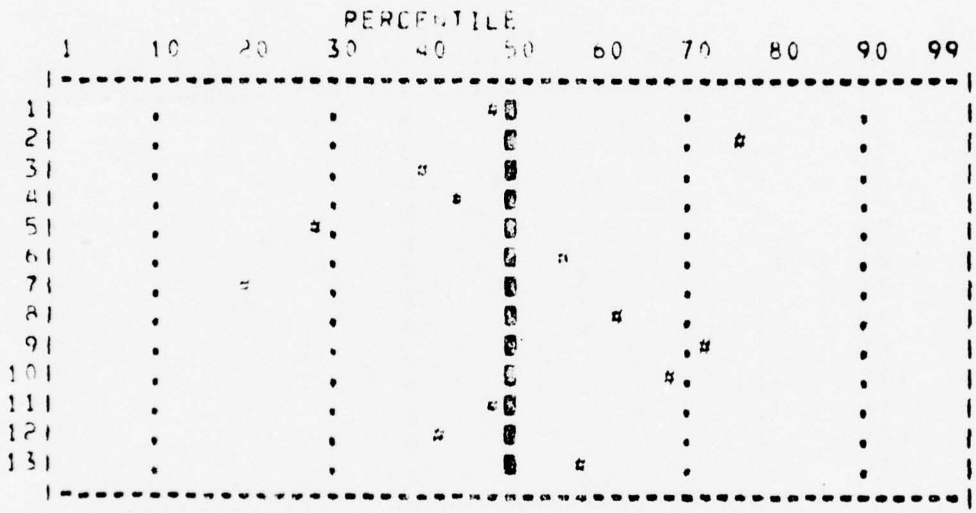


Figure 1 (Cont.)

A - 34



A - 35



A - 36

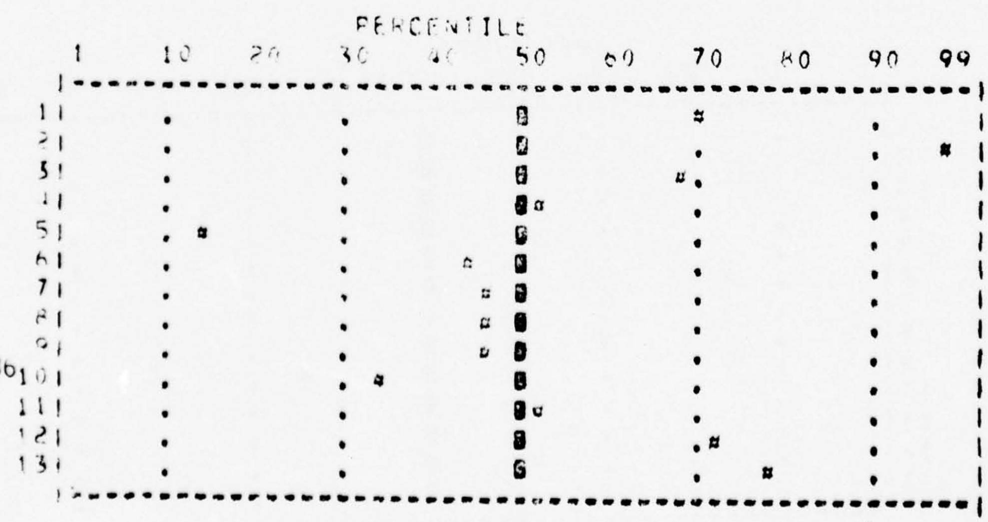
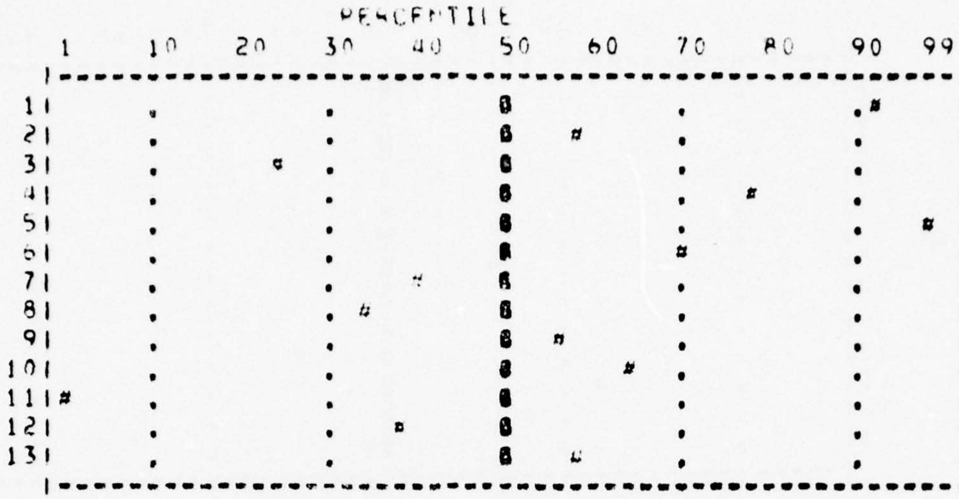
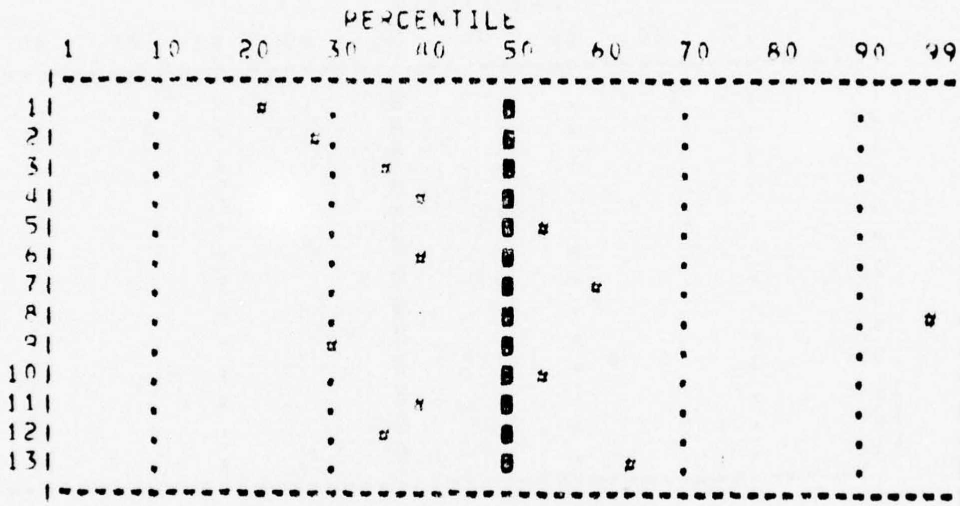


Figure 1 (Cont.)

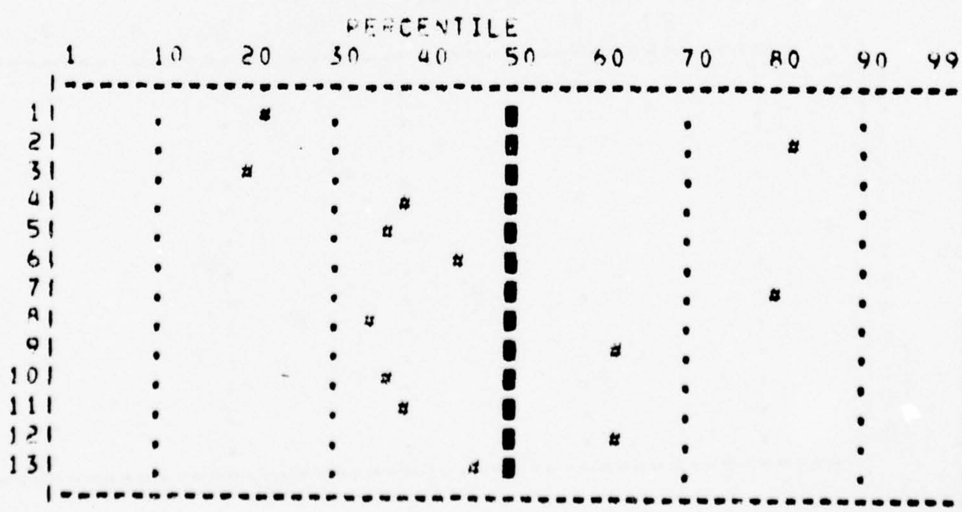
A - 37



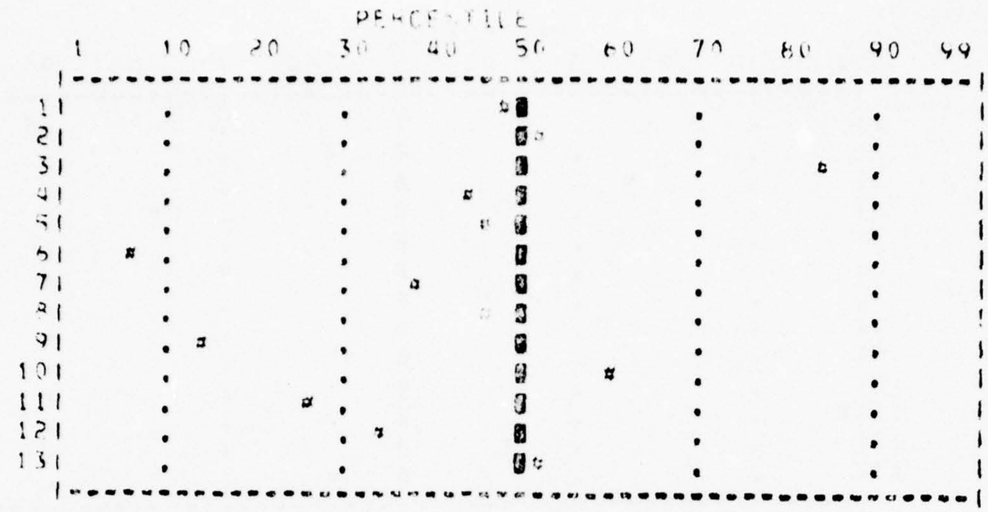
A - 38



A - 39



A - 40


PERCENTILE
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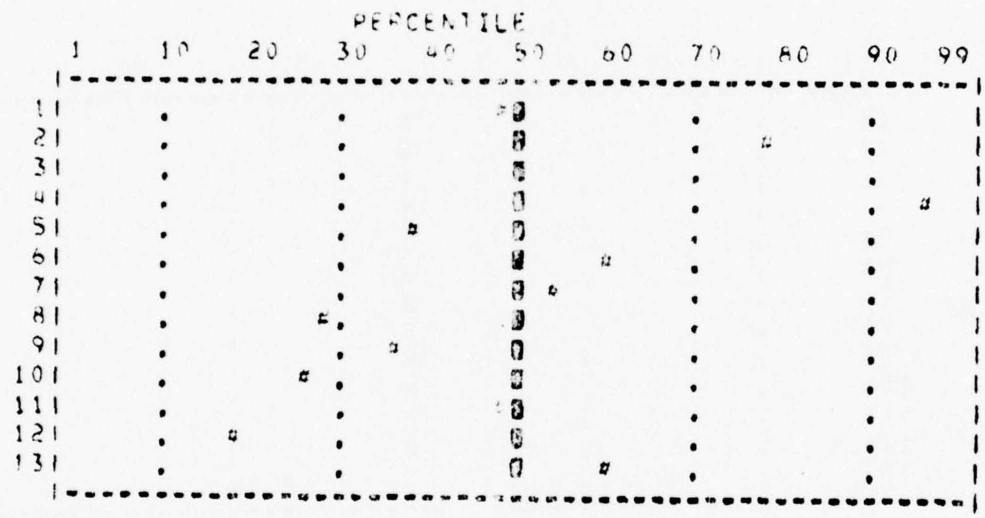
A - 41


PERCENTILE
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A - 42

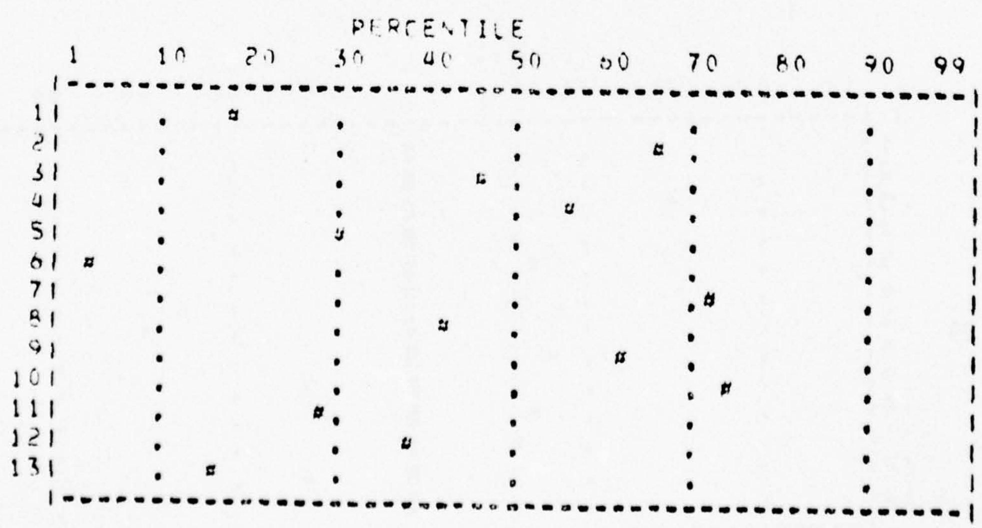
PERCENTILE
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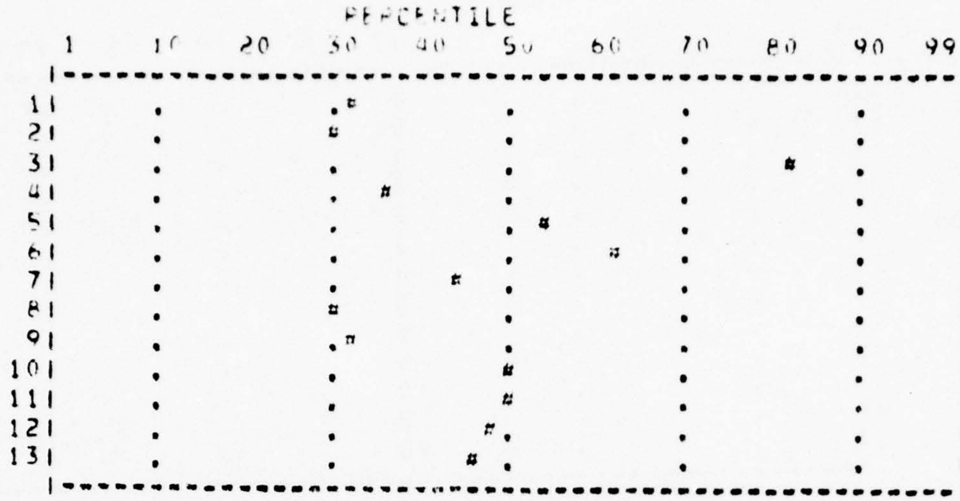
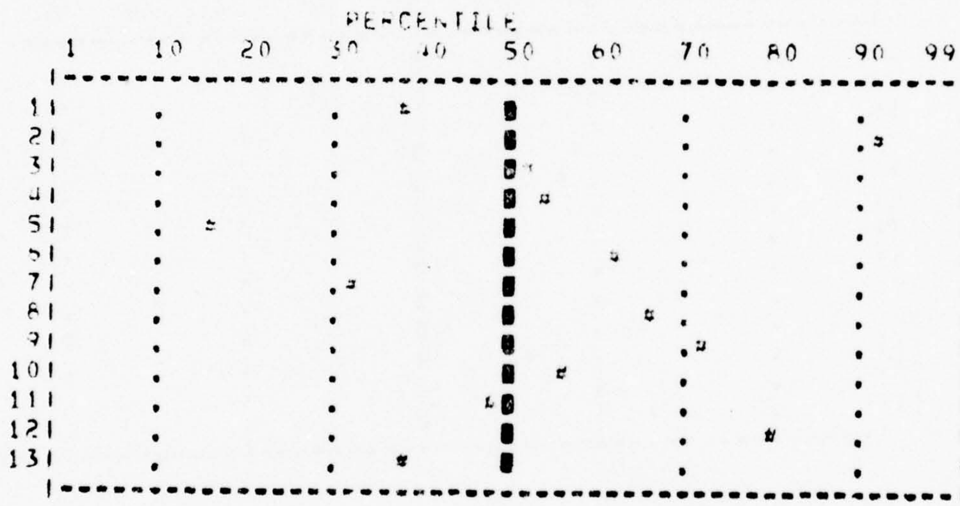
Figure 1 (Cont.)

A - 43



A - 44



A - 45

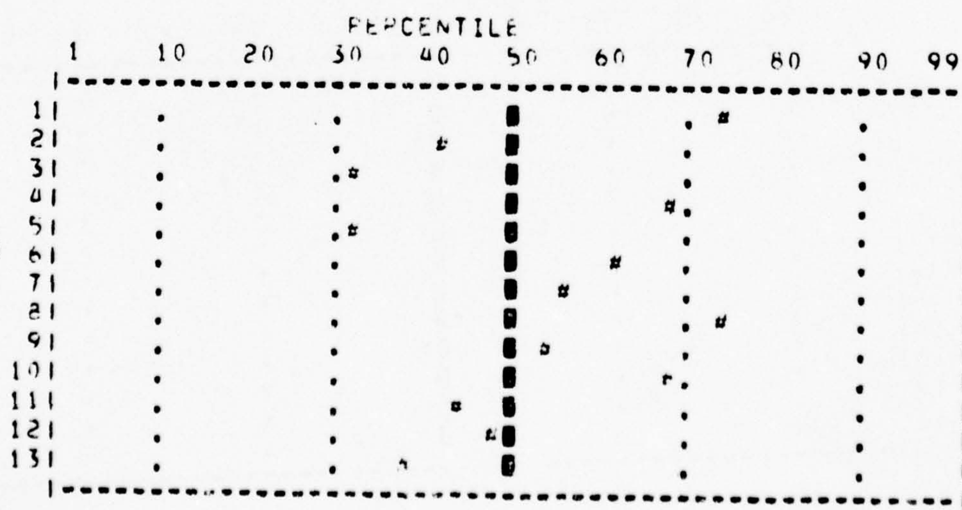
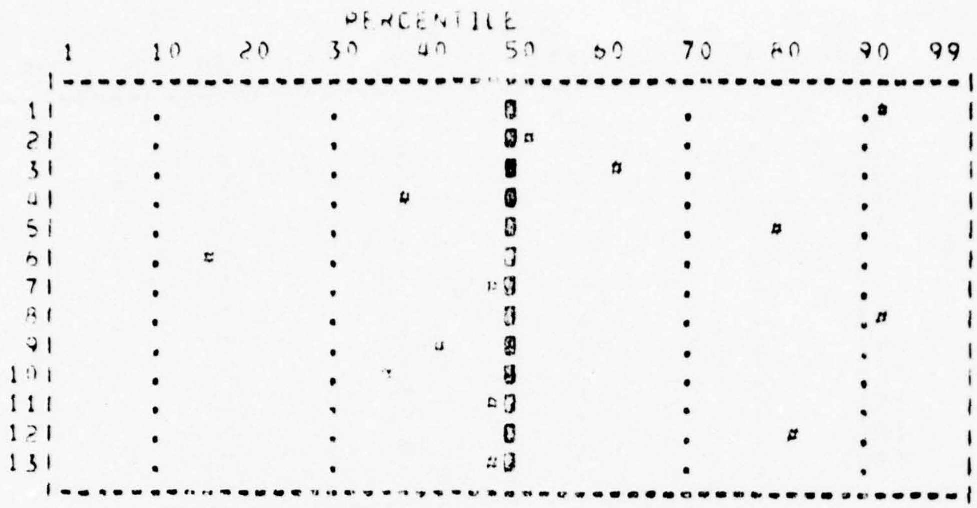
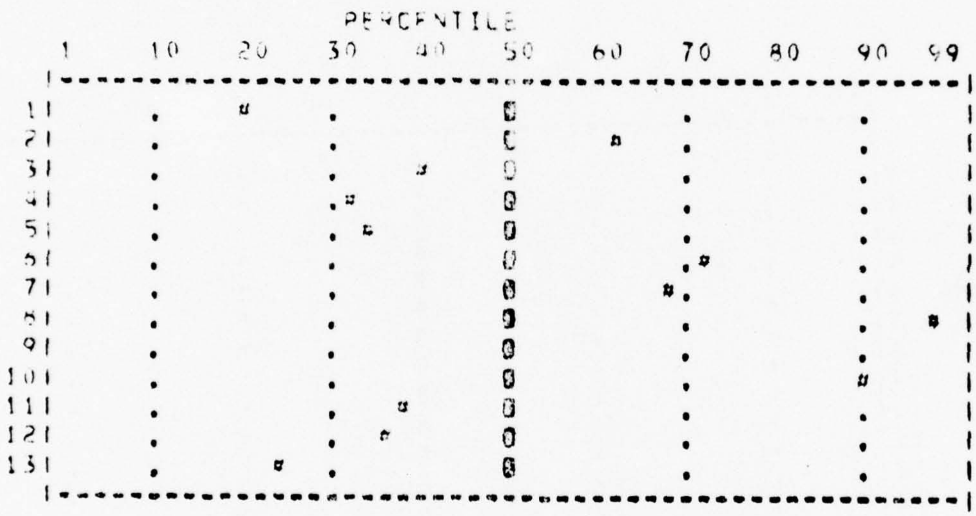


Figure 1 (Cont.)

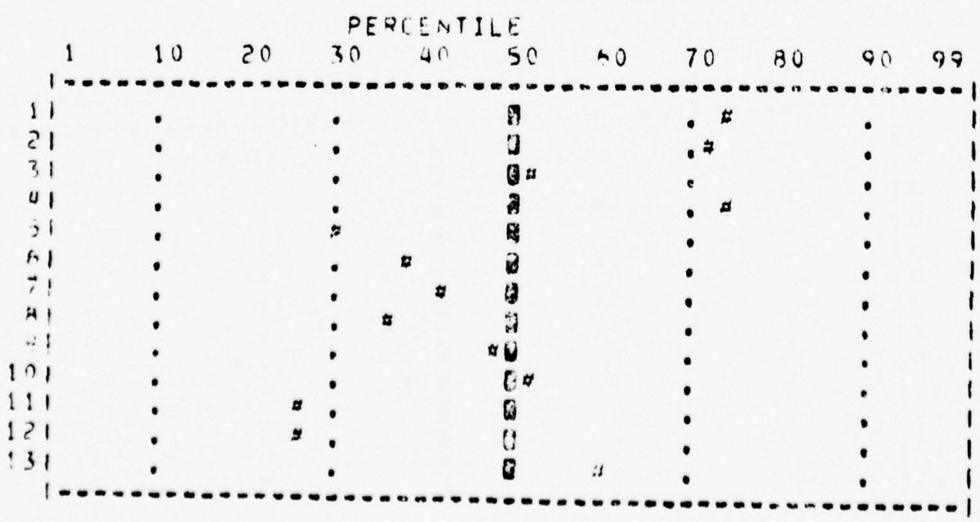
A - 46



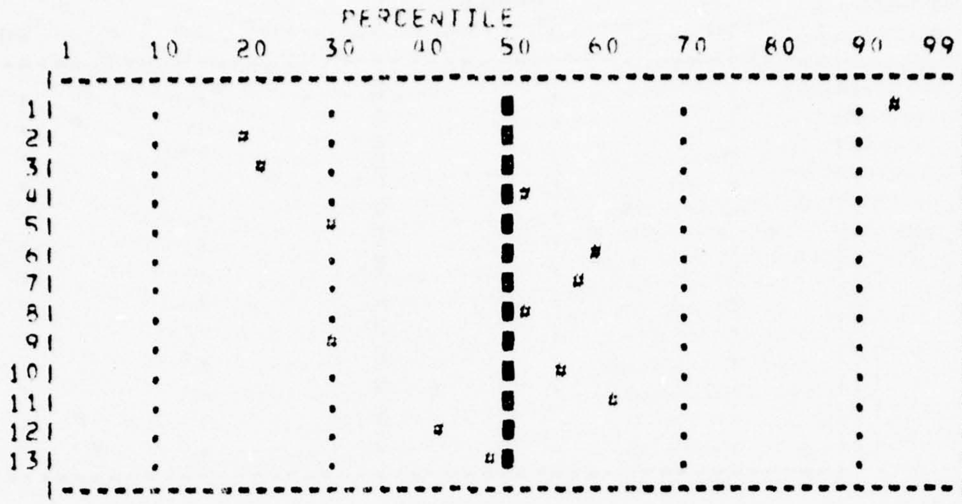
A - 47



A - 48



A - 49


PERCENTILE
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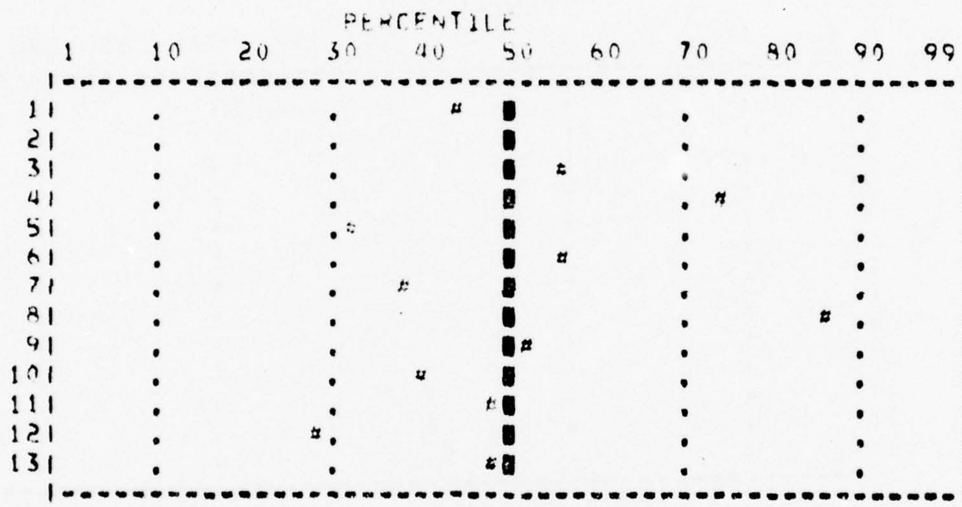
A - 50


PERCENTILE
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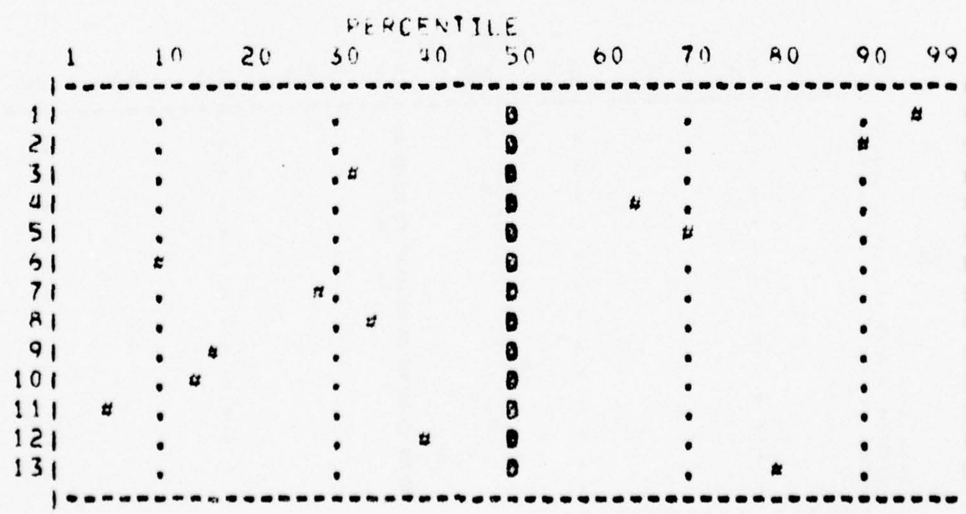
A - 51


PERCENTILE
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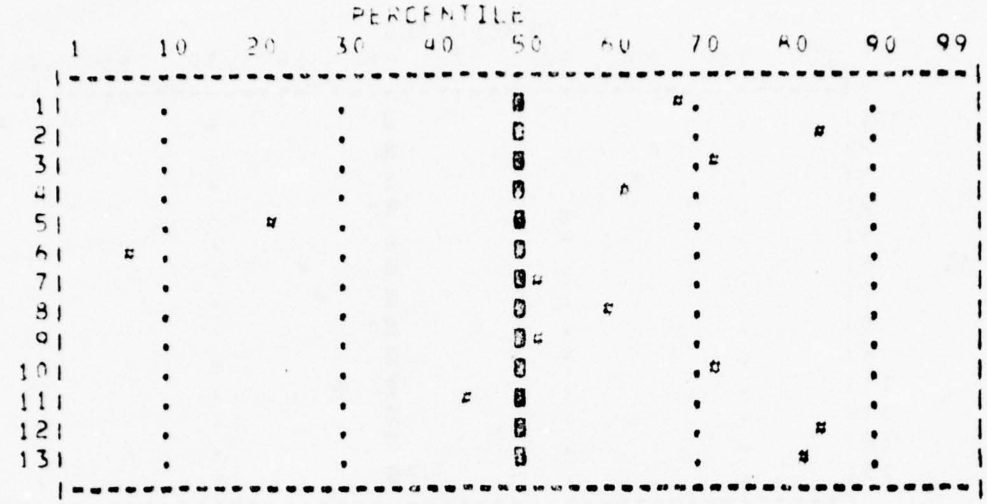
A - 52


PERCENTILE
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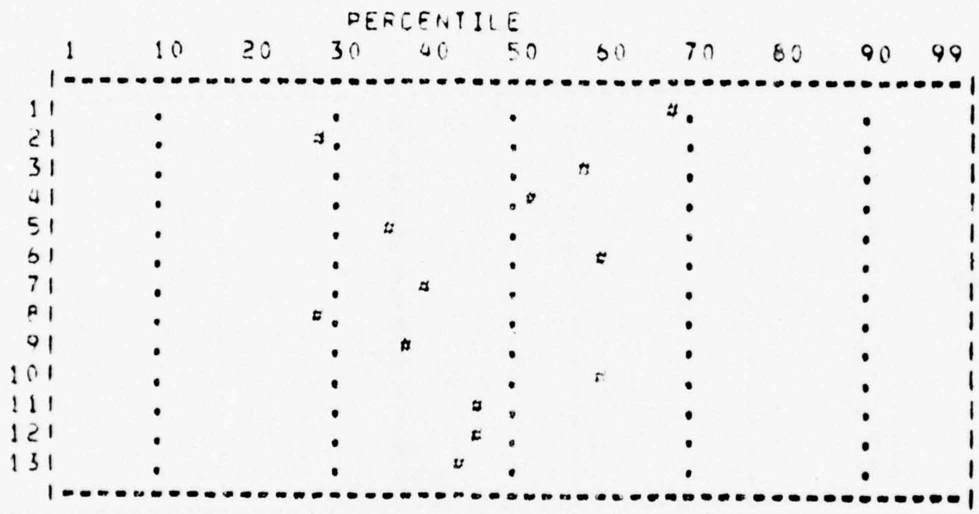
A - 53


PERCENTILE
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A - 54

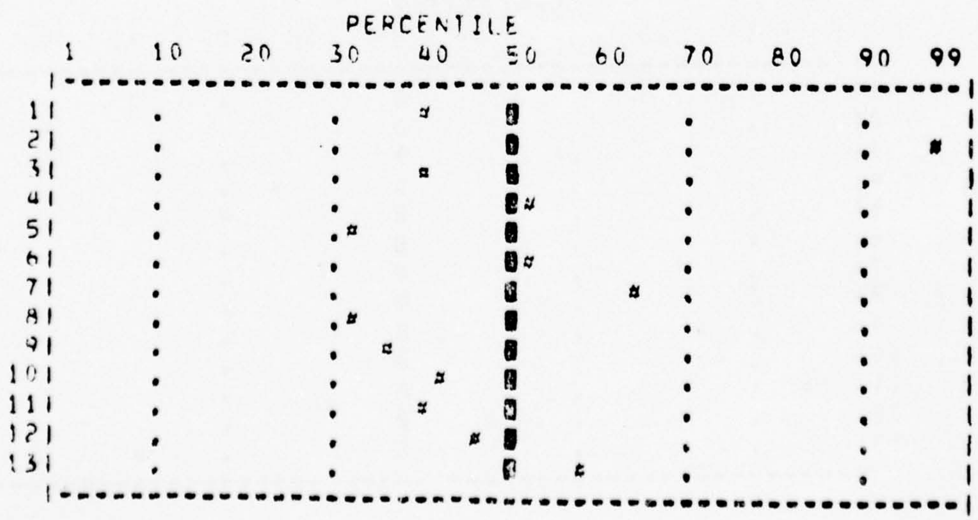
PERCENTILE
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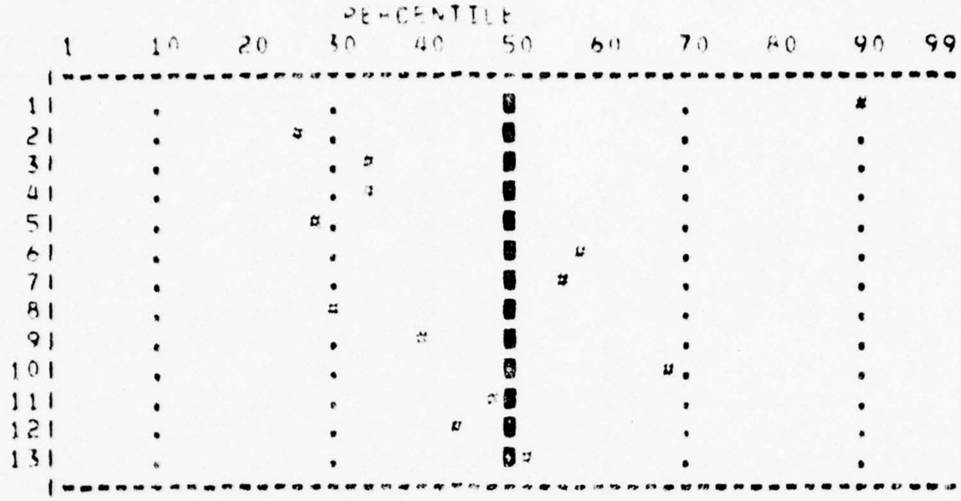
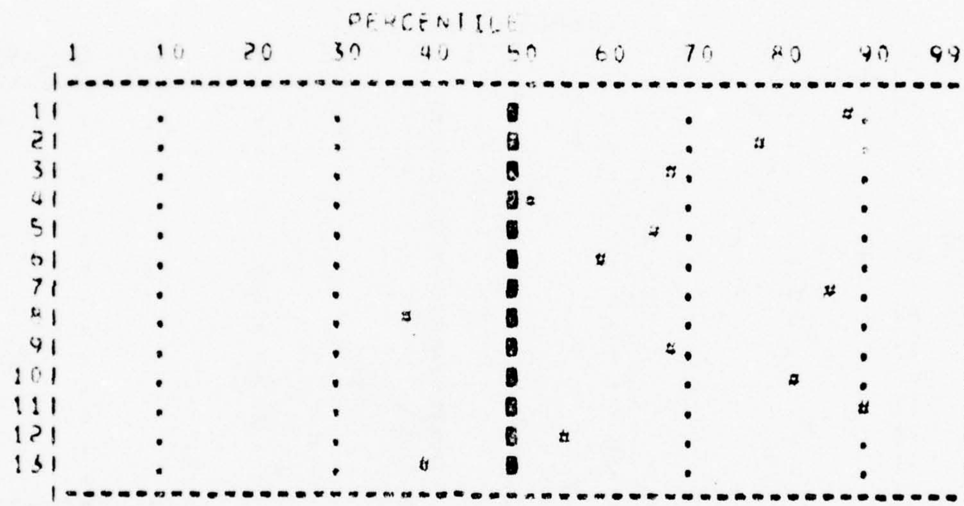
Figure 1 (Cont.)

A - 55



A - 56



A - 57

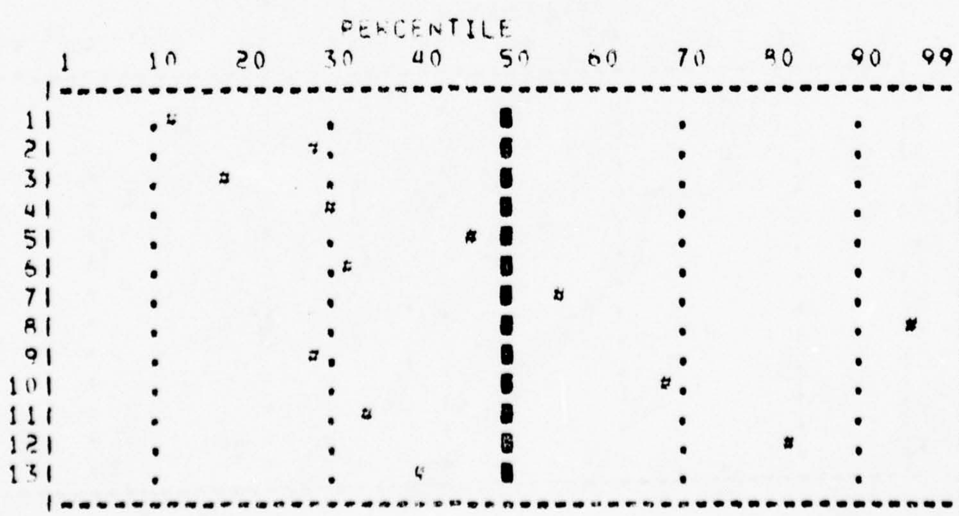
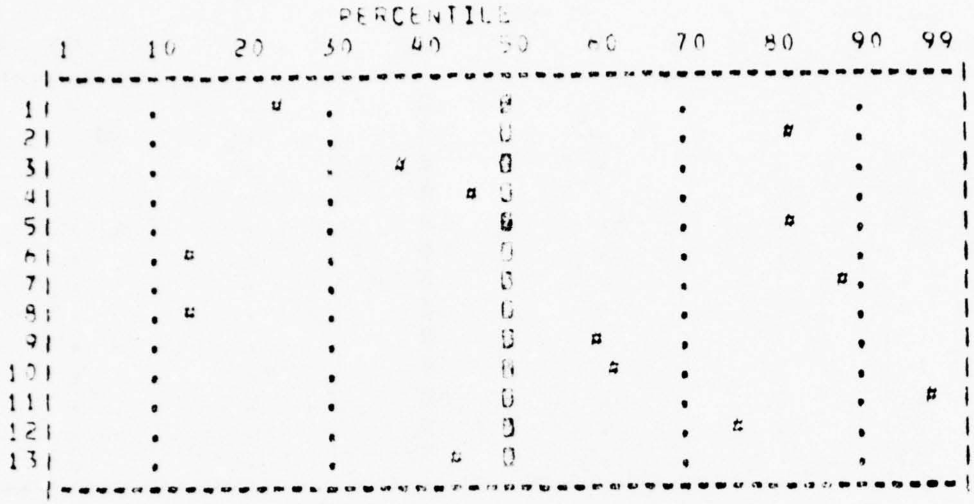
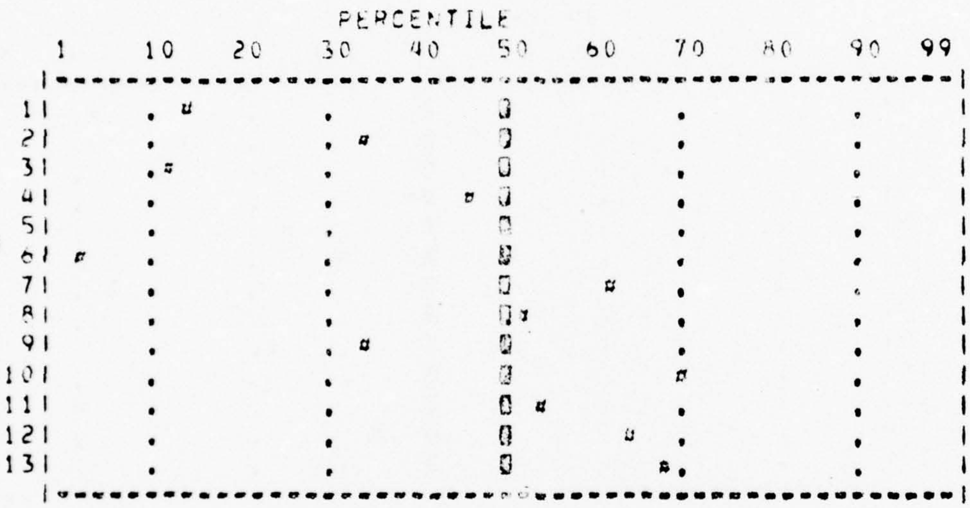


Figure 1 (Cont.)

A - 58



A - 59



A - 60

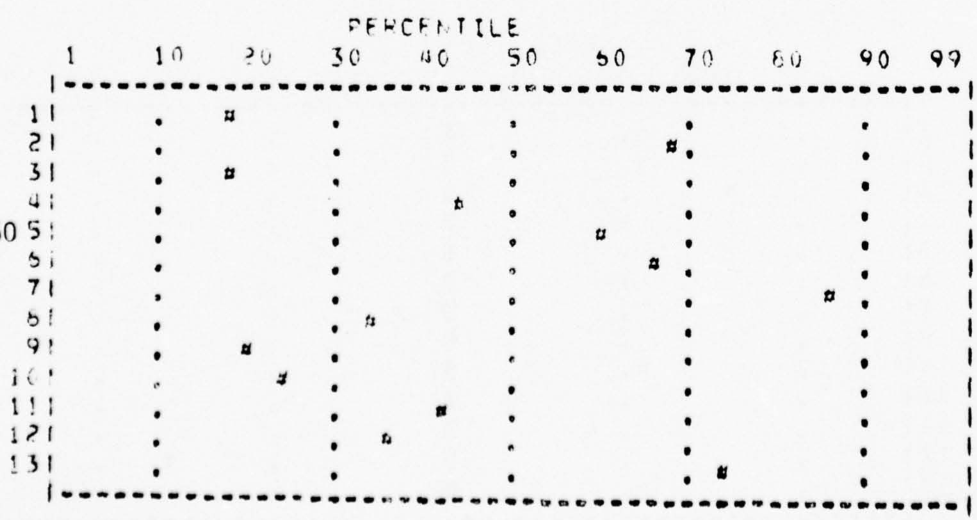
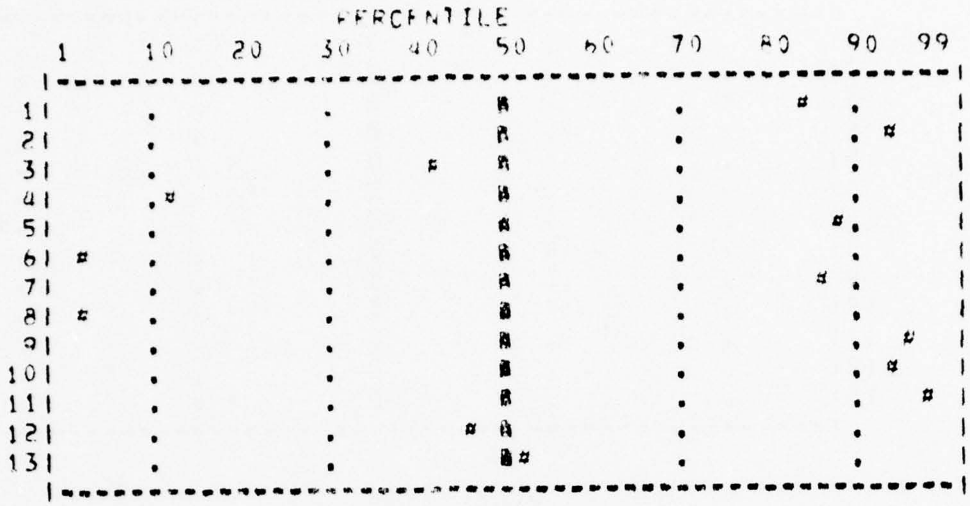
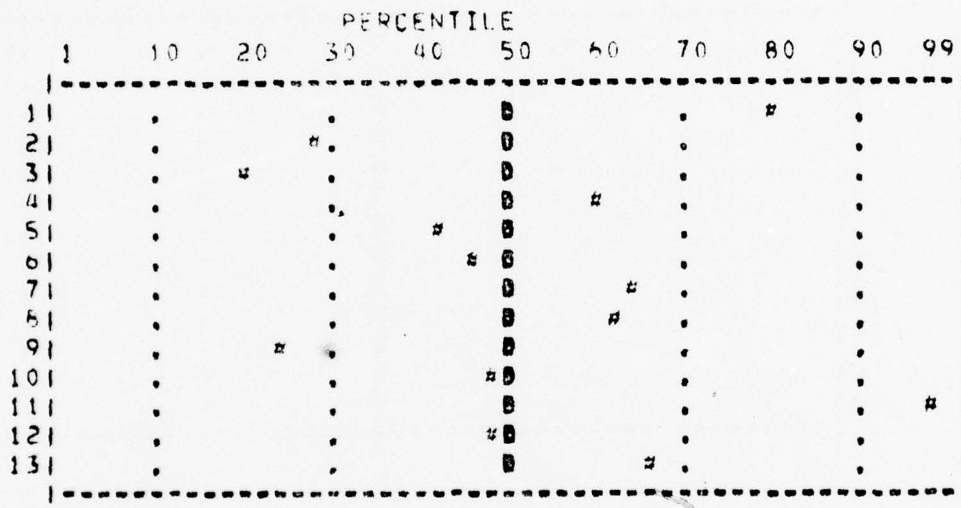


Figure 1 (Cont.)

B - 1



B - 2



B - 3

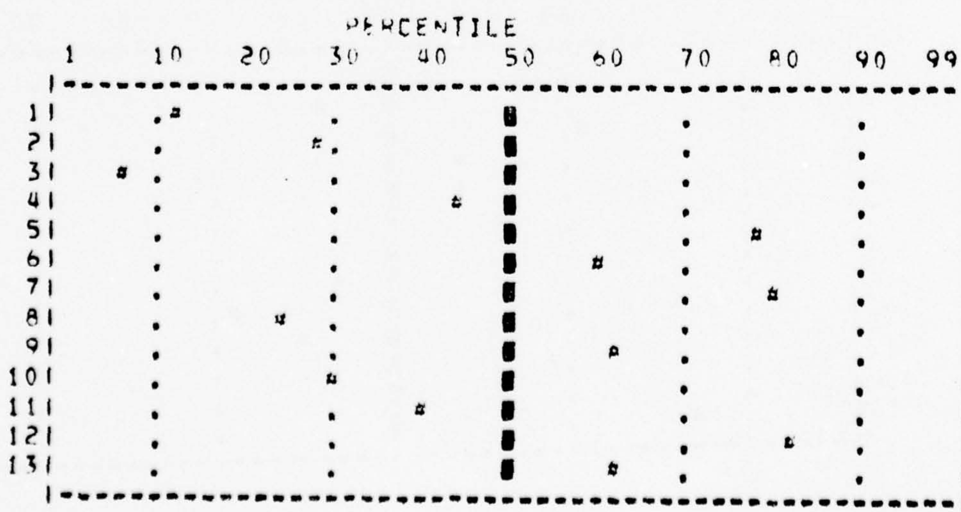
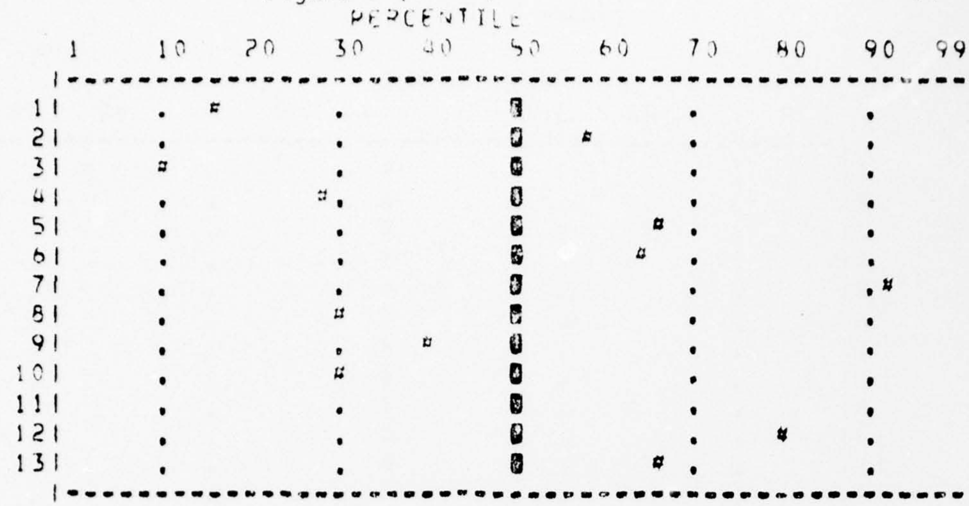
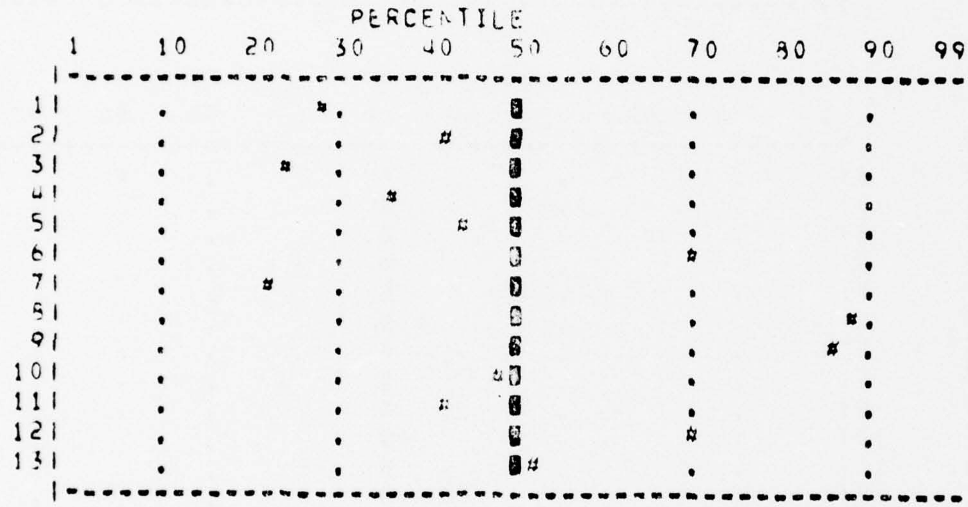


Figure 1 (Cont.)

B - 4



B - 5



B - 6

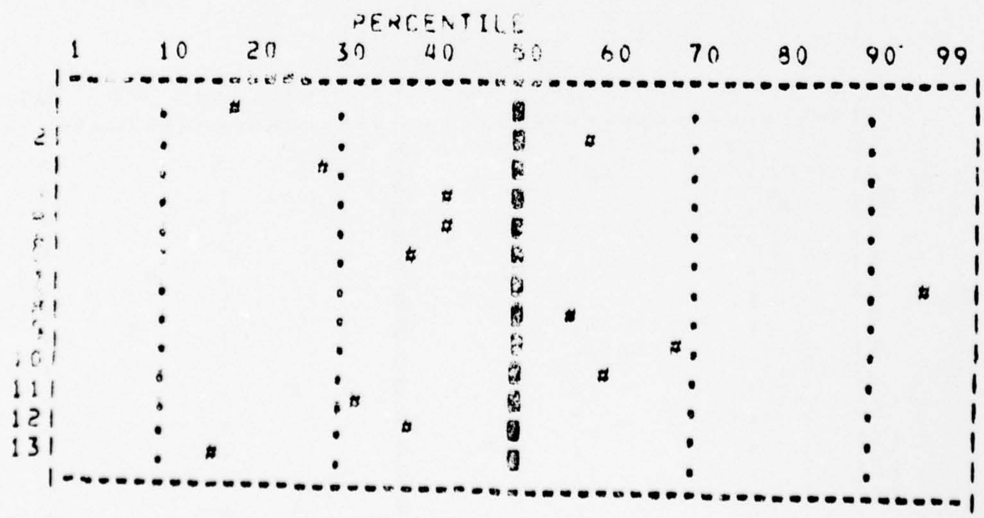
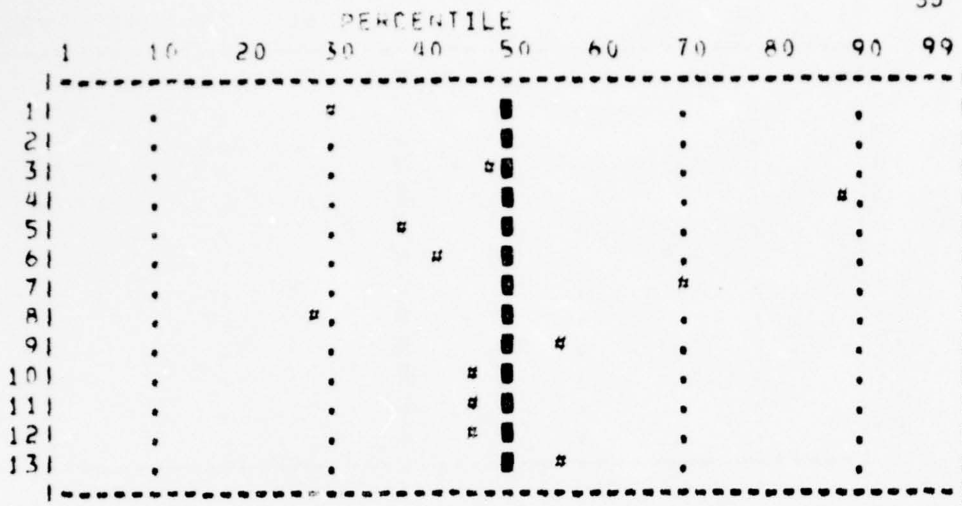
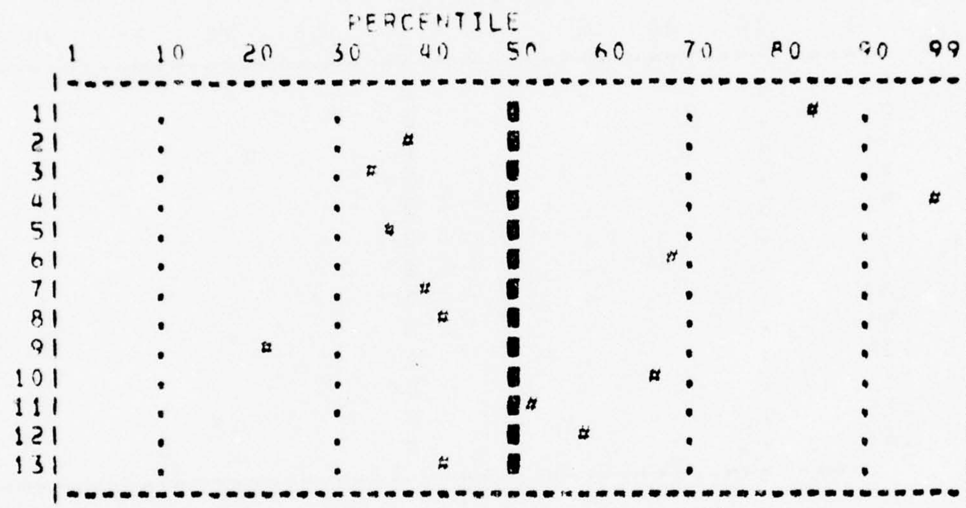


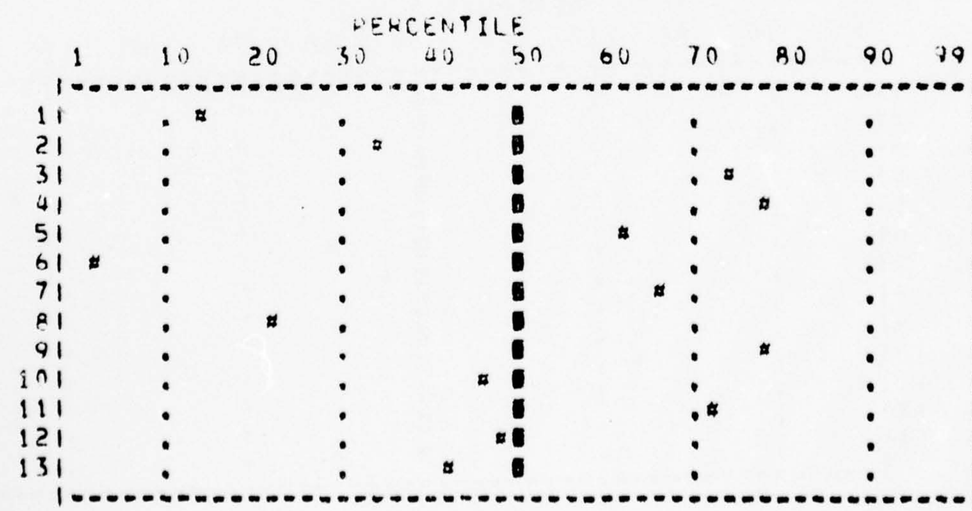
Figure 1 (Cont.)



B - 7

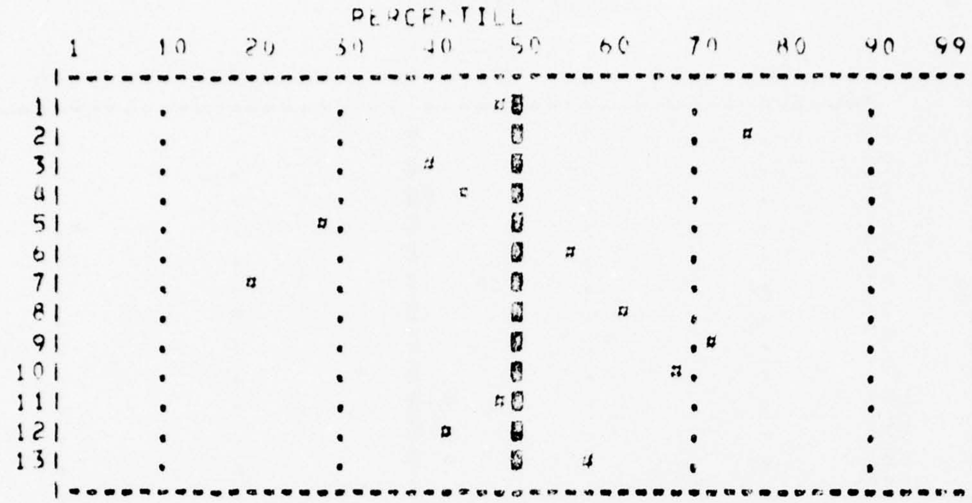


B - 8

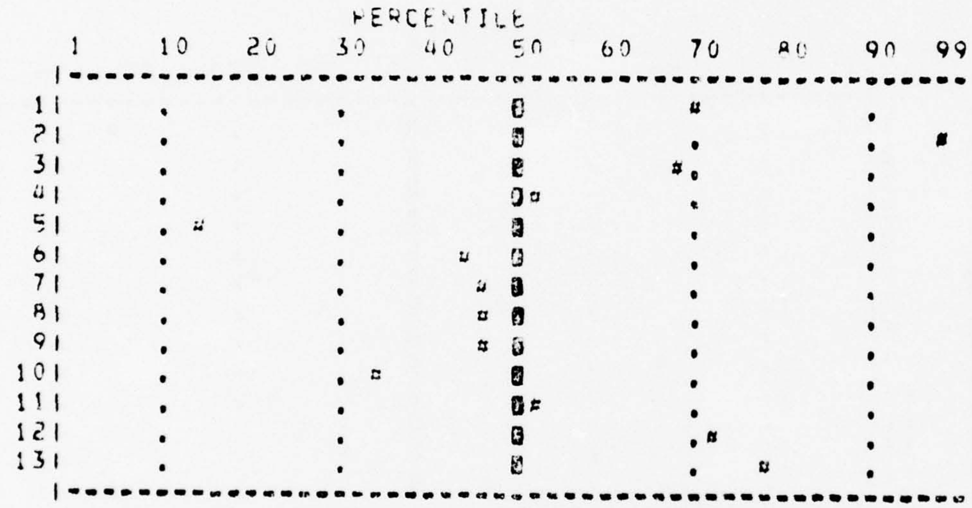


B - 9

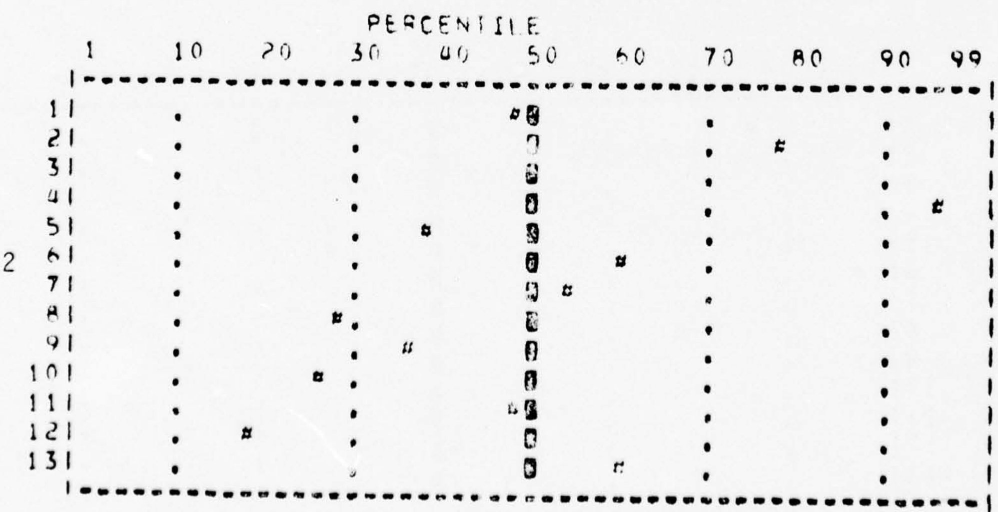
Figure 1 (Cont.)



B - 10

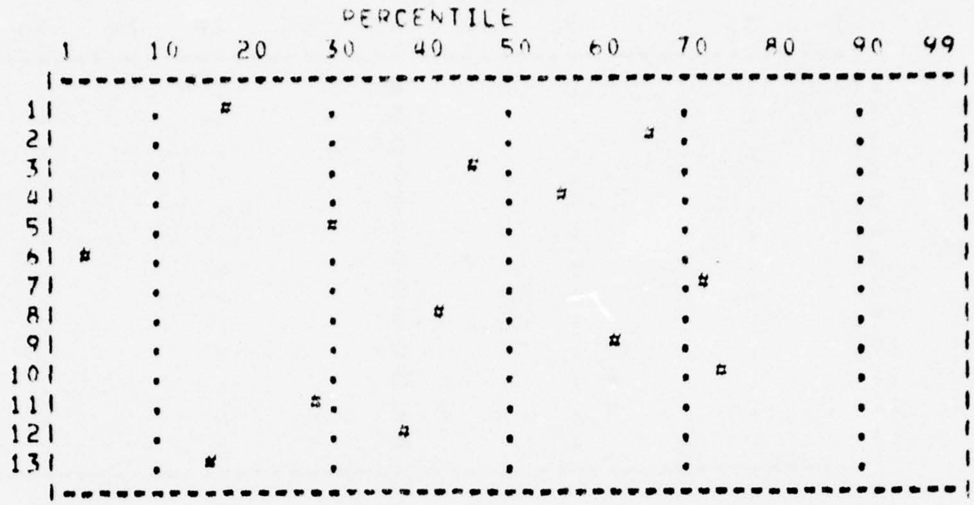


B - 11



B - 12

B - 13


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
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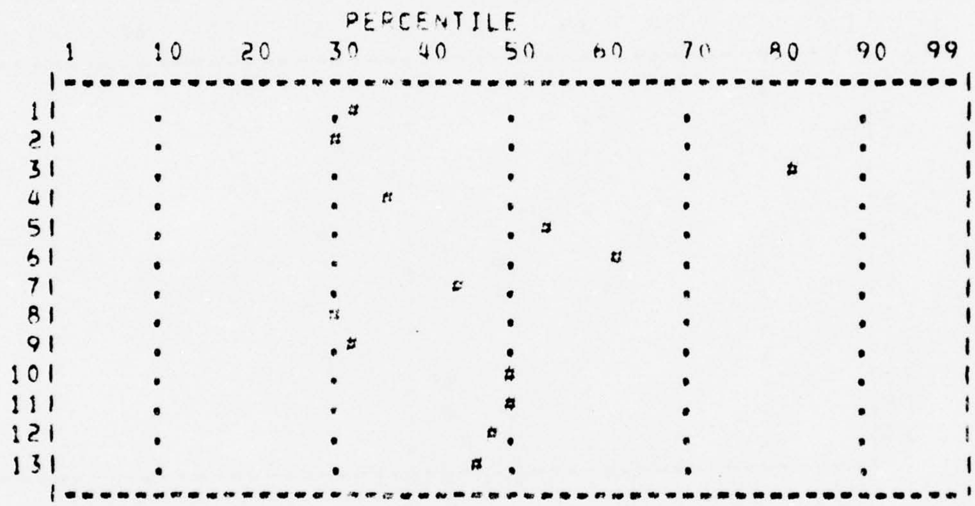
B - 14


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
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B - 15

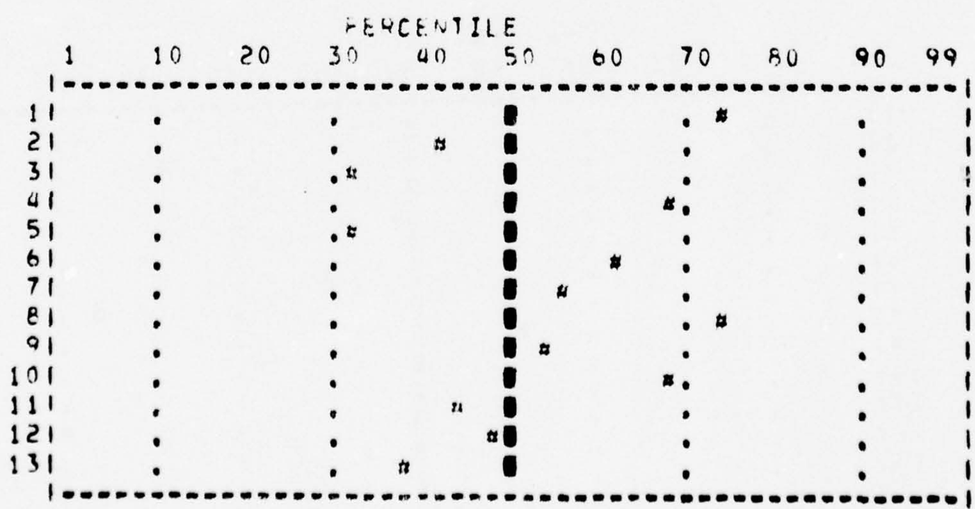
PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
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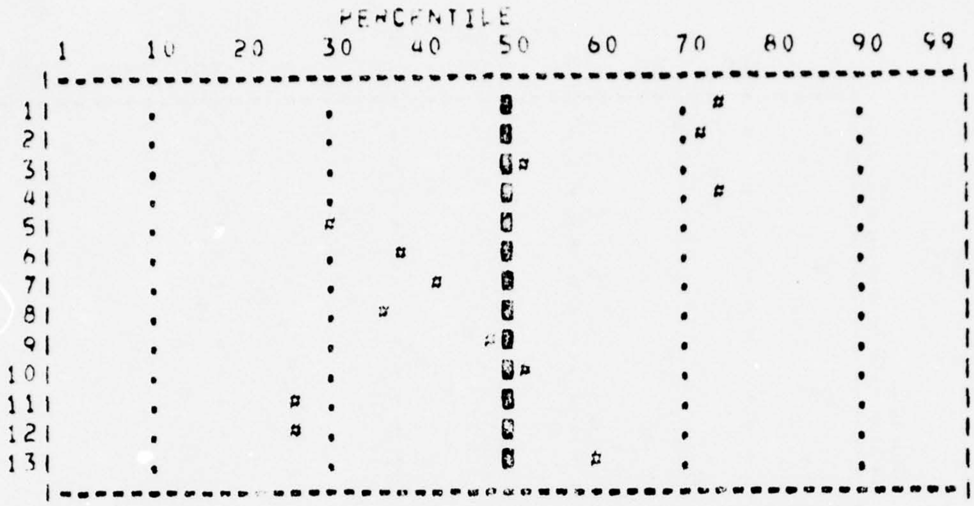
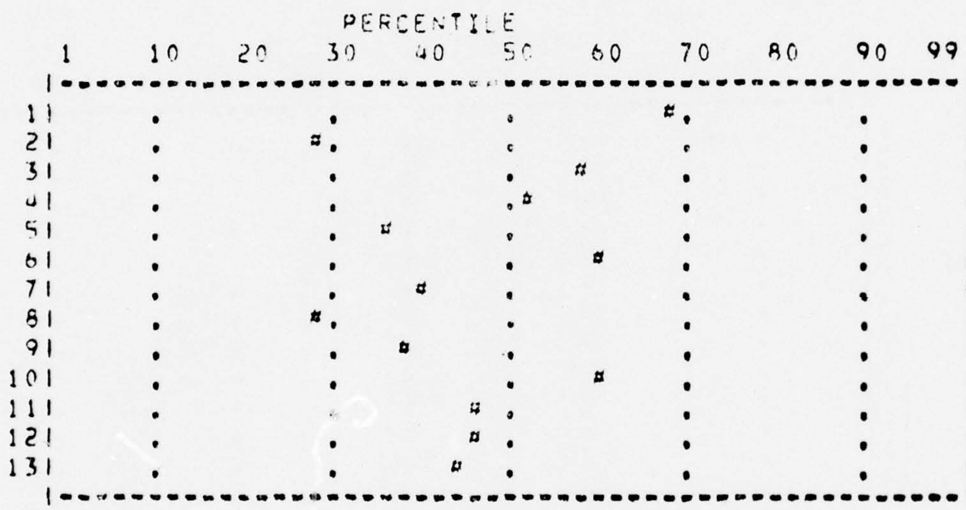
Figure 1 (Cont.)

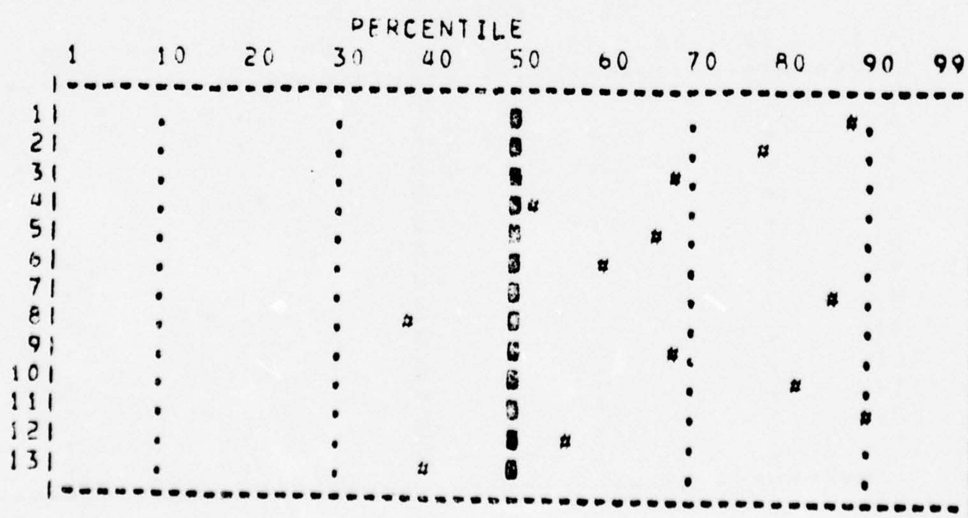
B - 16



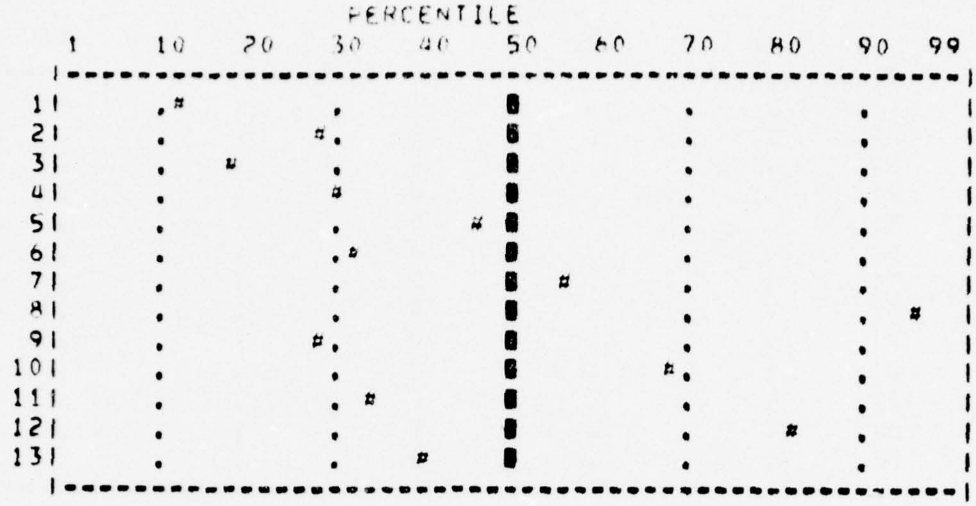
B - 17



B - 18



B - 19


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
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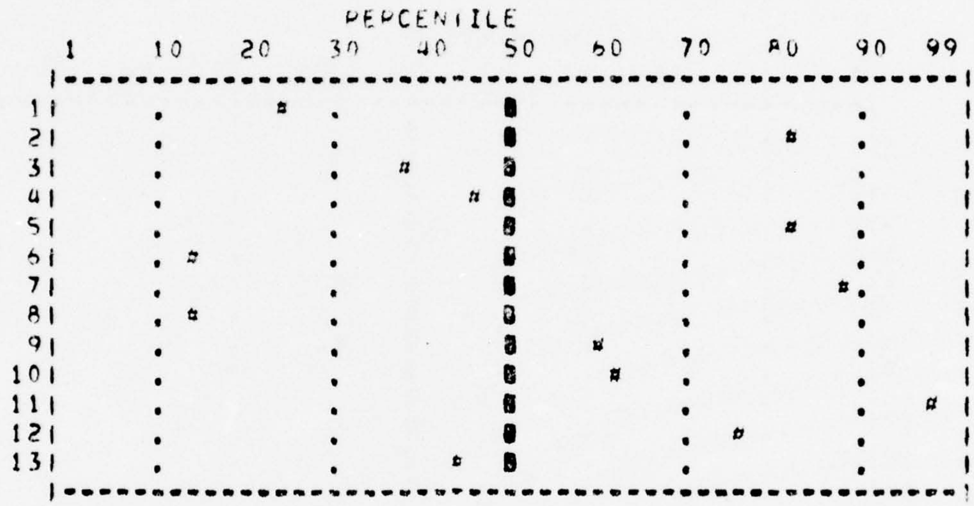
B - 20


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
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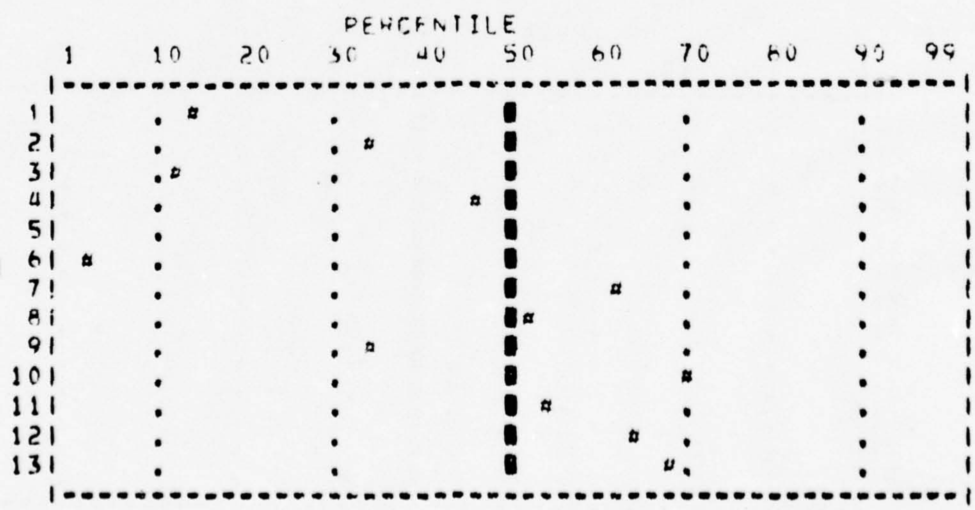
B - 21


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
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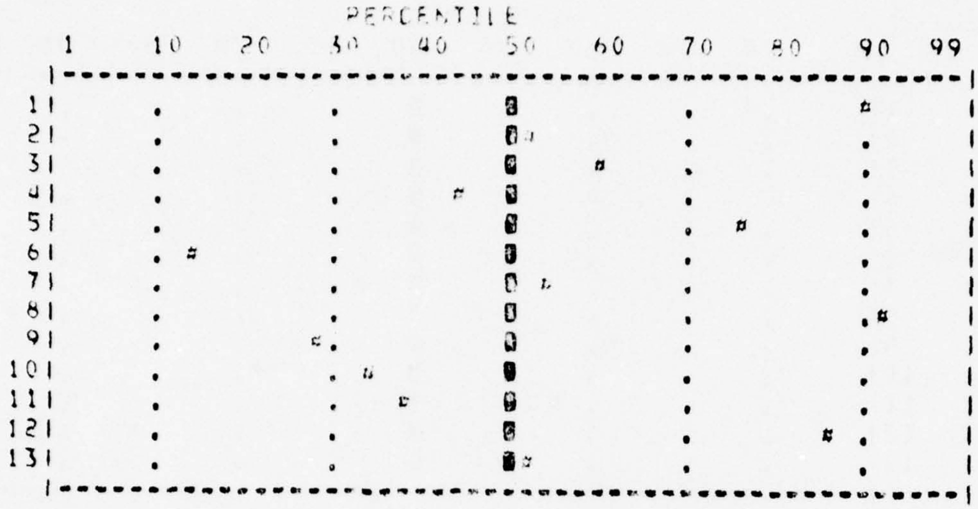
B - 22


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
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6
7
8
9
10
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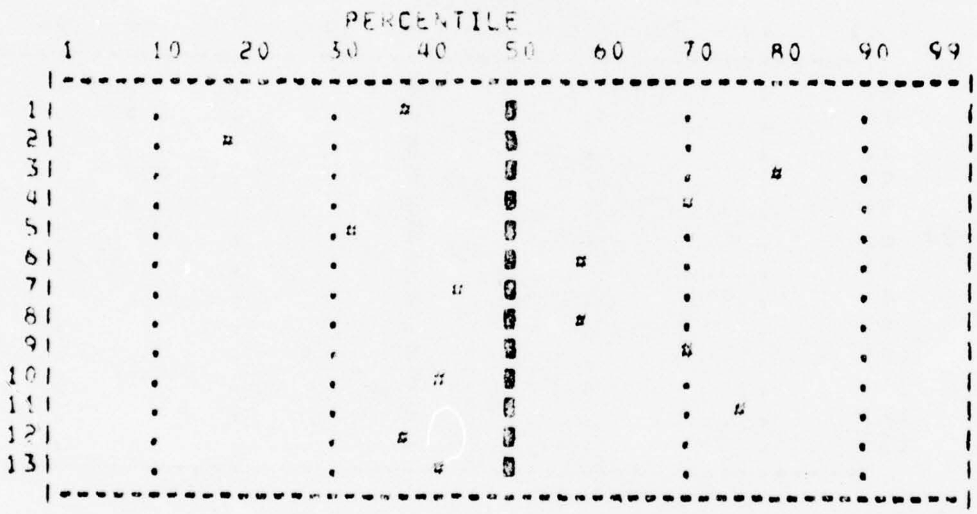
12
13

B - 23


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
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9
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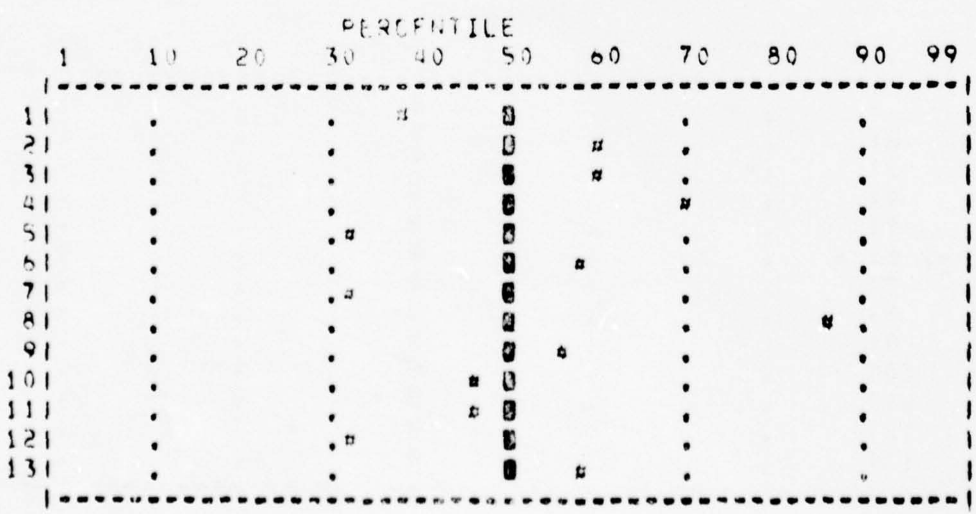
13

B - 24


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
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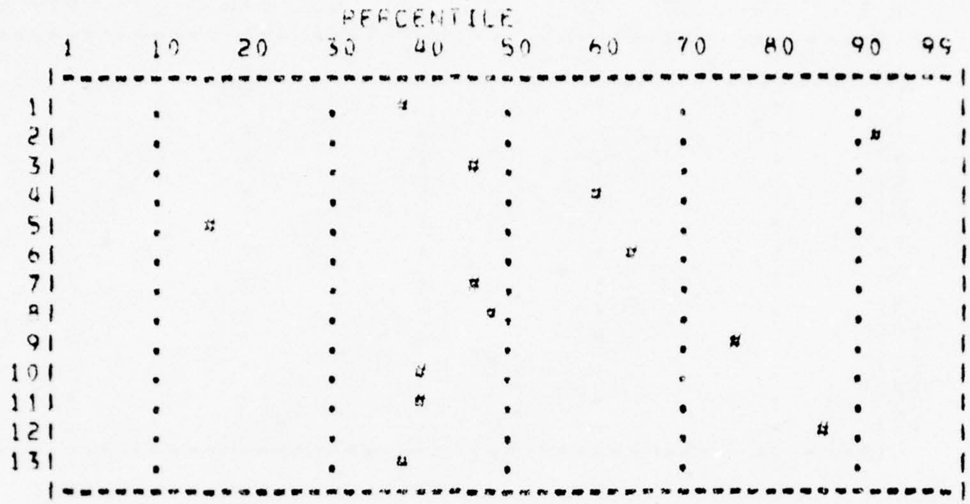
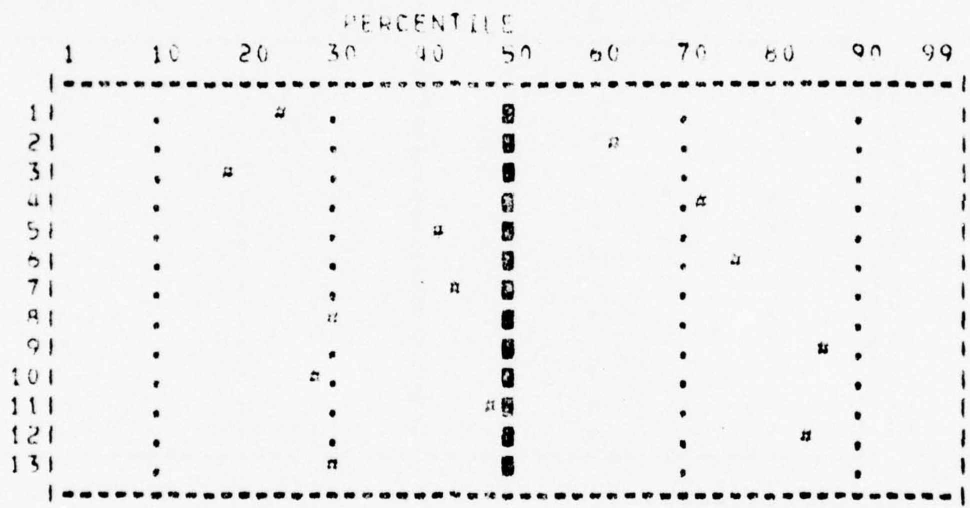
11
12
13

Figure 1 (Cont.)

B - 25



B - 26



B - 27

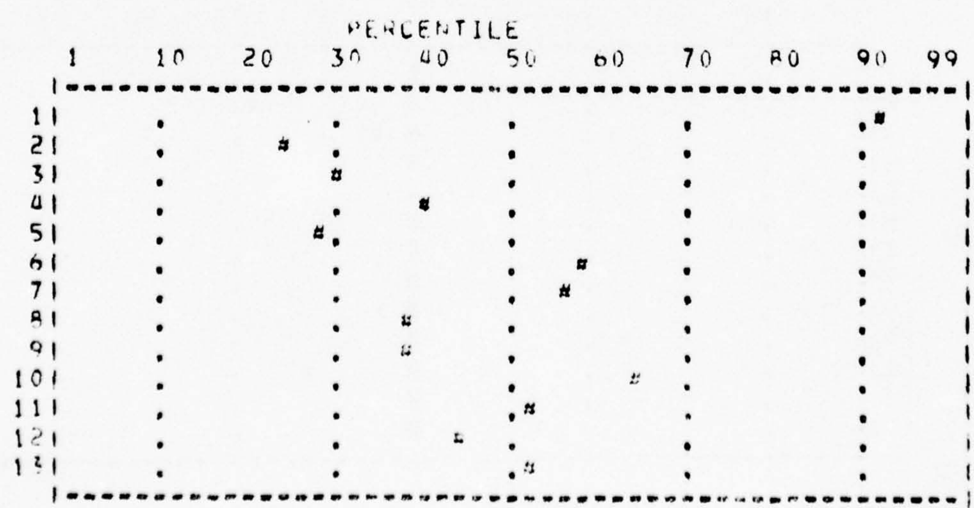
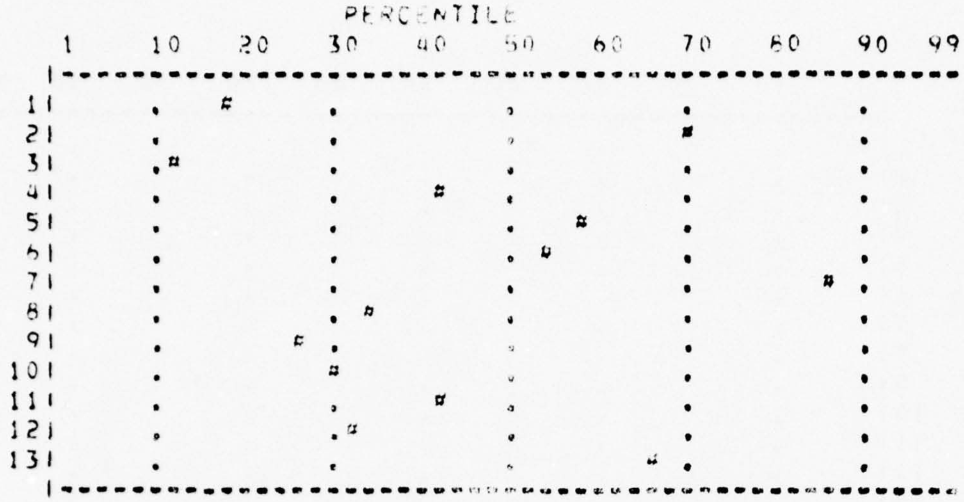
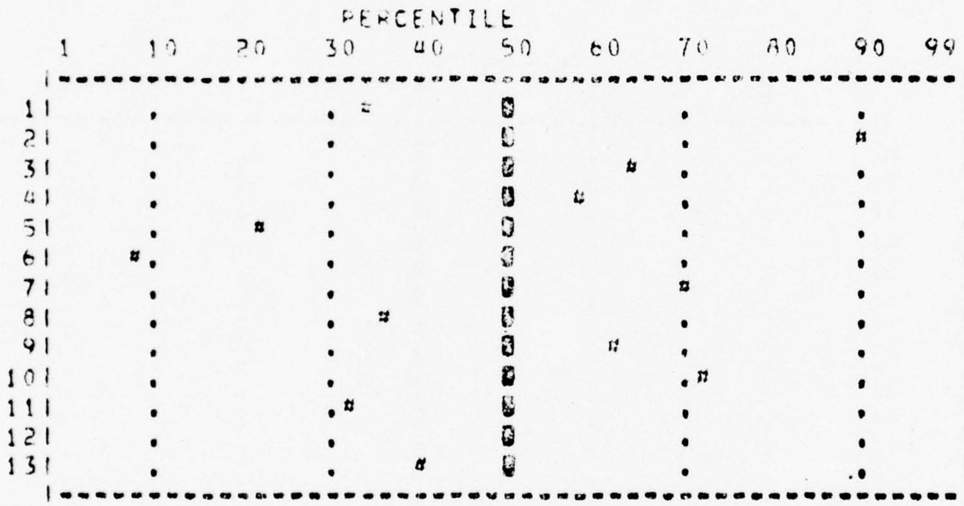


Figure 1 (Cont.)

B - 28



B - 29



B - 30

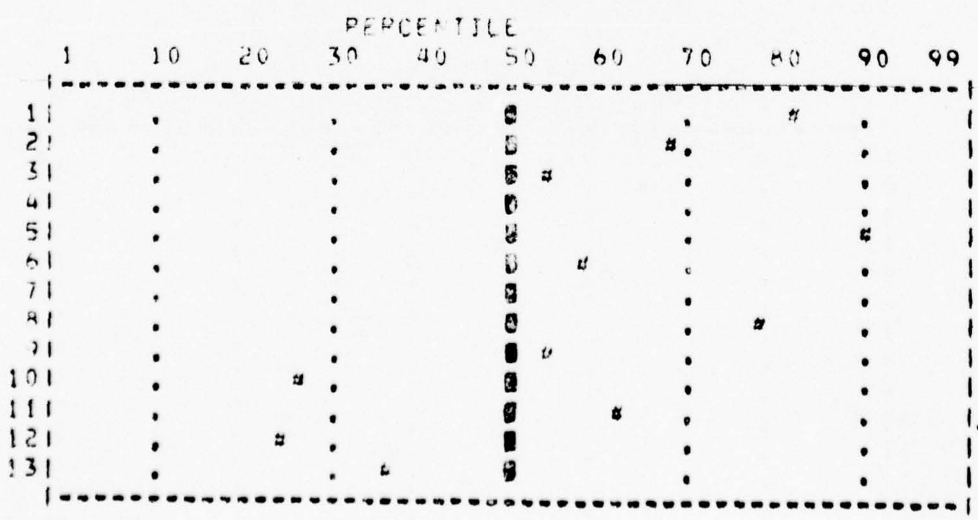
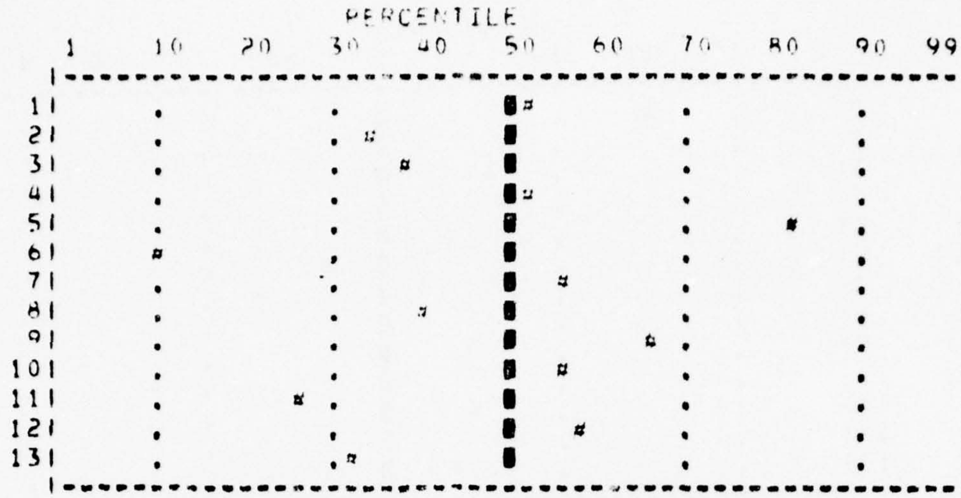
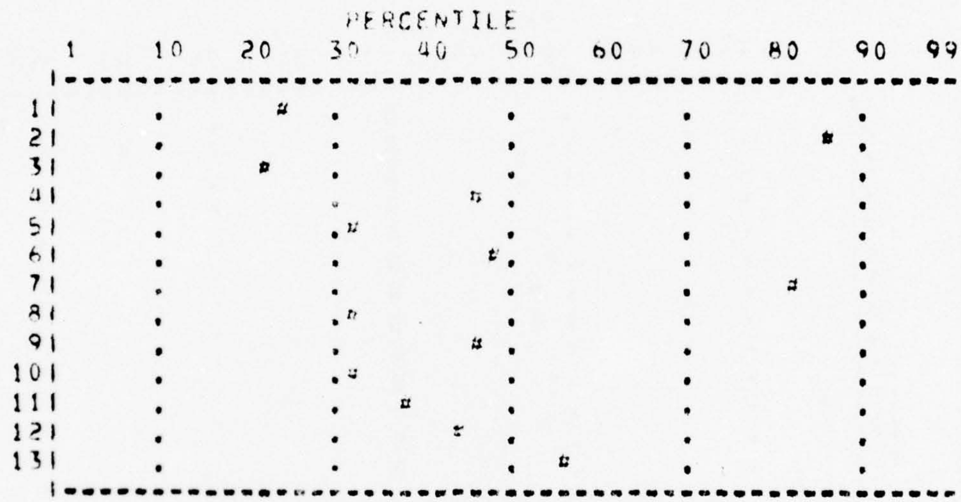


Figure 1 (Cont.)

B - 31



B - 32



B - 33

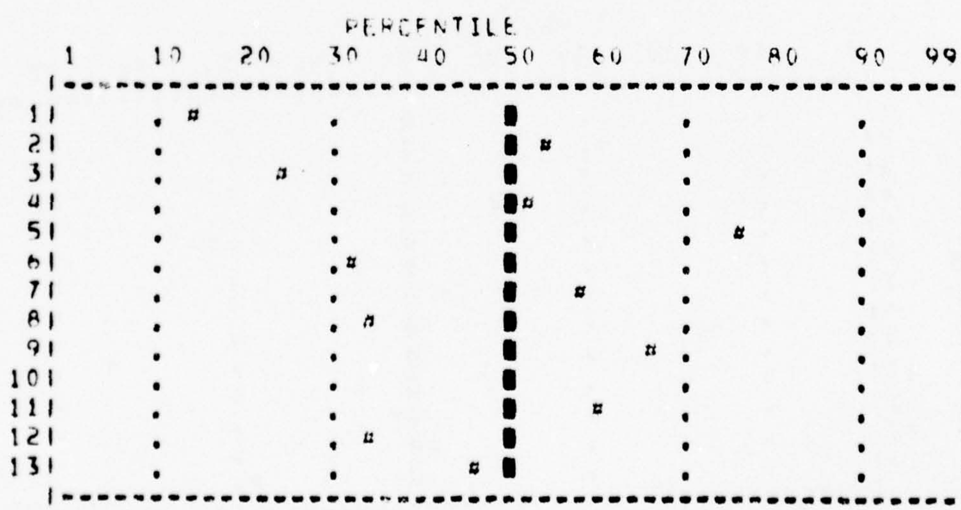
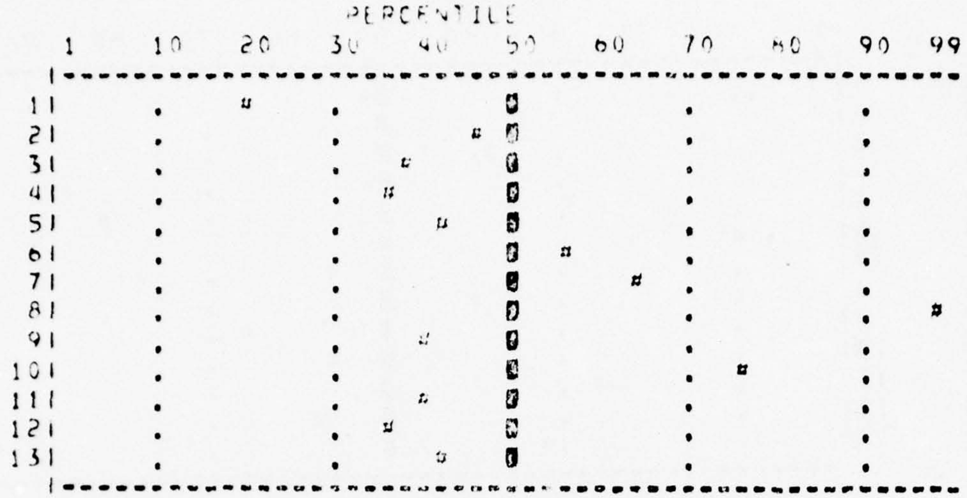
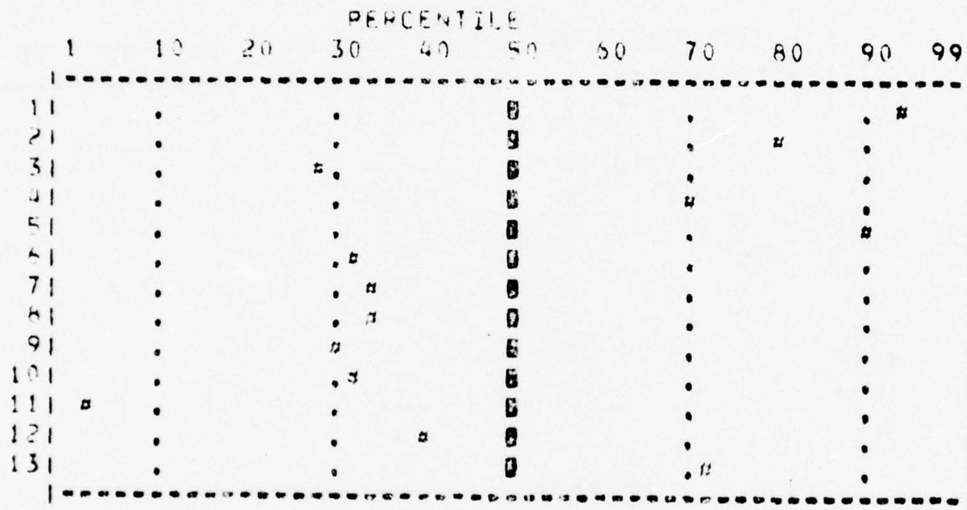


Figure 1 (Cont.)

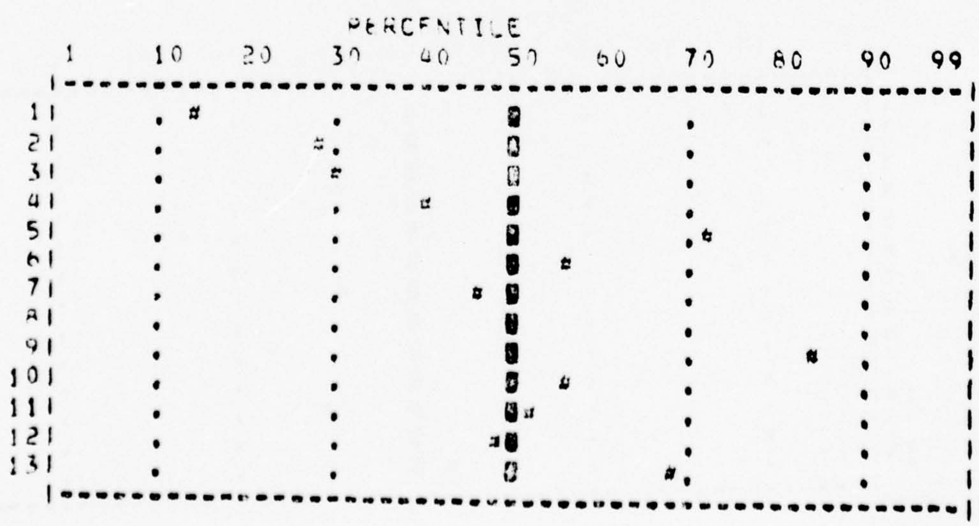
B - 34



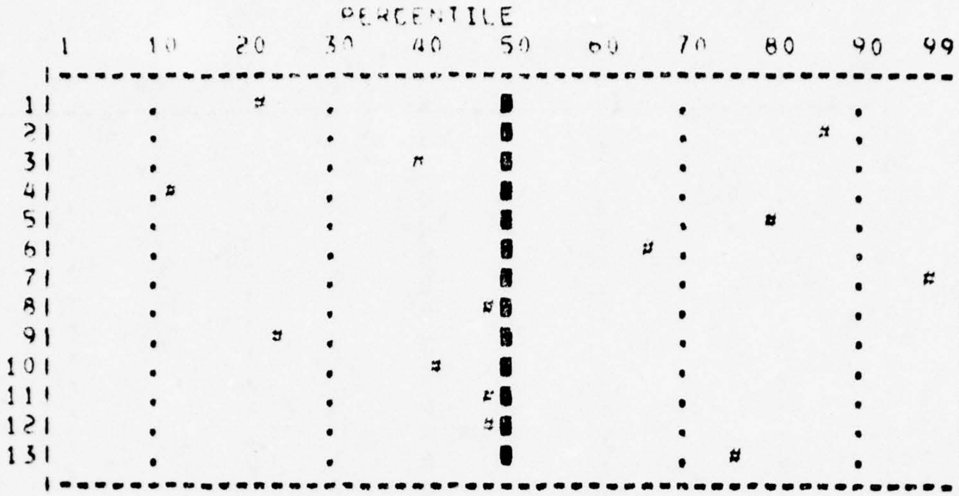
B - 35



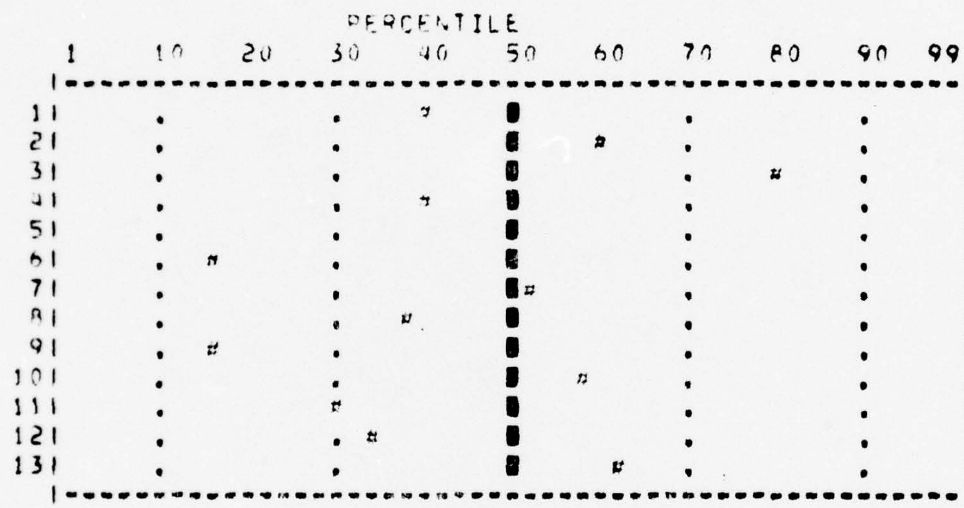
B - 36



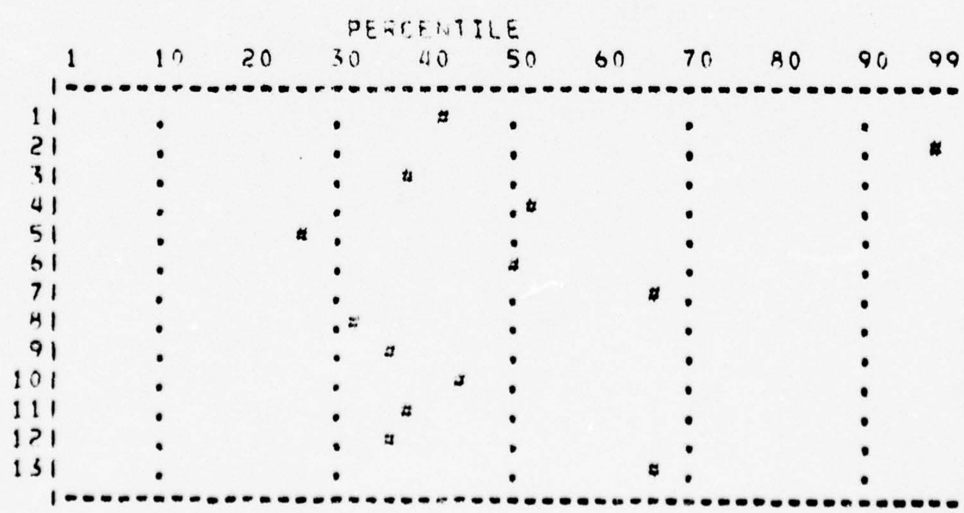
B - 37


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1 2 3 4 5 6 7 8 9 10 11 12 13

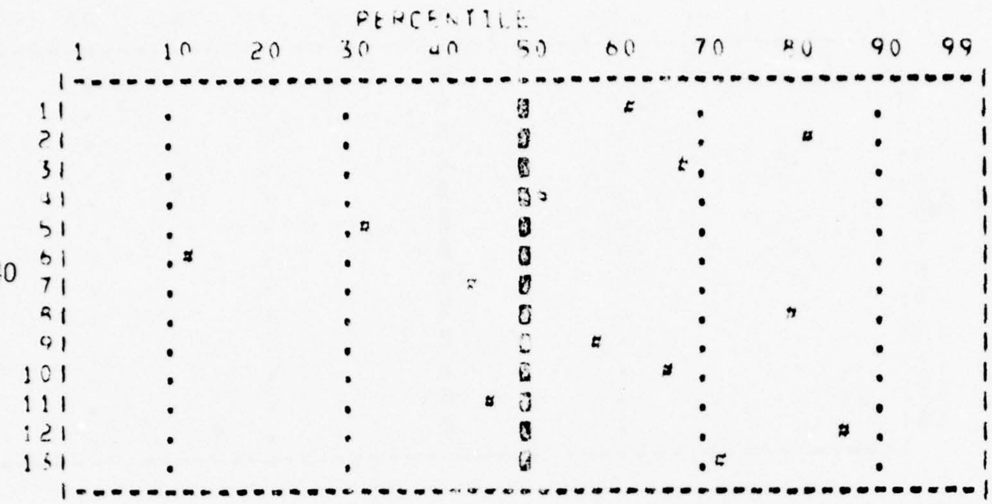
B - 38


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1 2 3 4 5 6 7 8 9 10 11 12 13

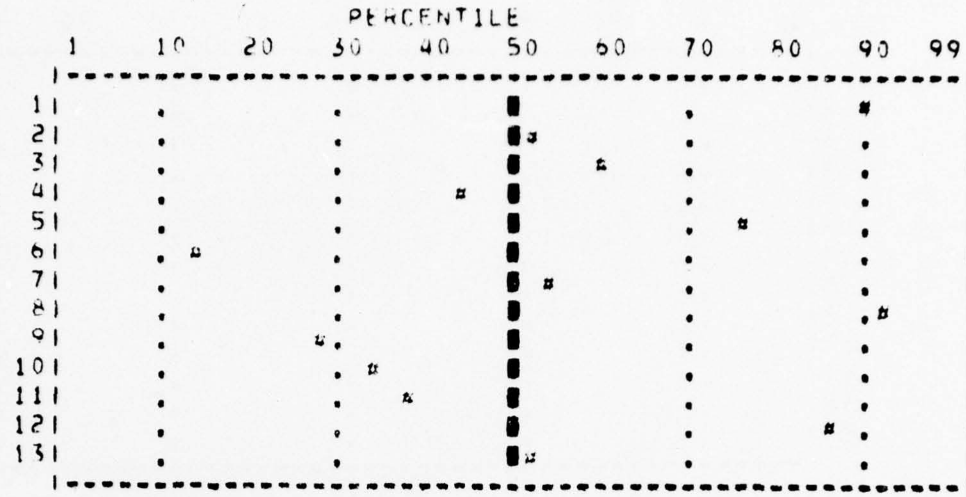
B - 39


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1 2 3 4 5 6 7 8 9 10 11 12 13

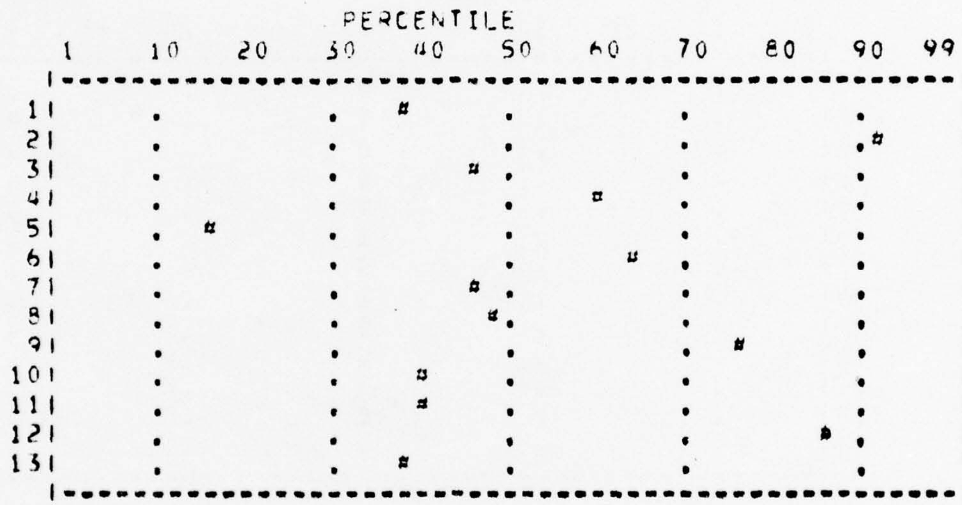
B - 40



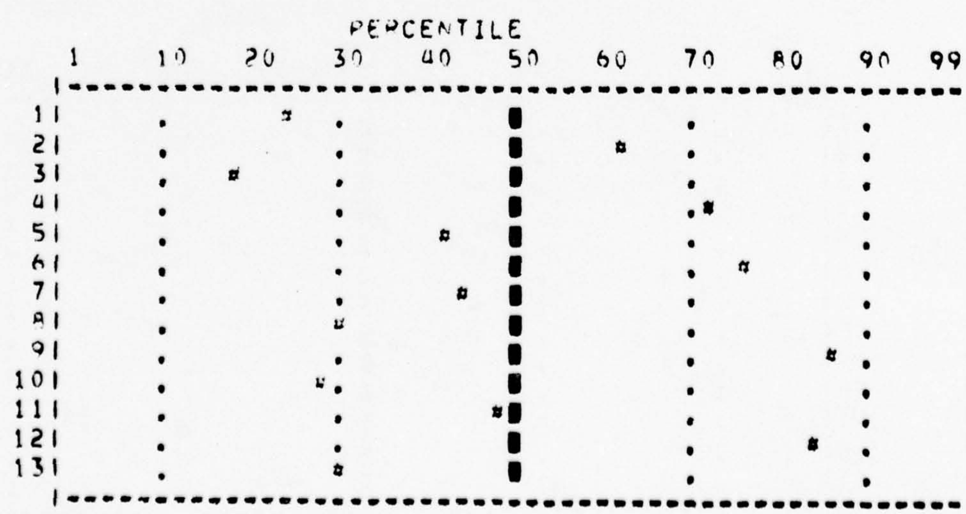
C - 1


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
2
3
4
5
6
7
8
9
10
11
12
13

C - 2


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
2
3
4
5
6
7
8
9
10
11
12
13

C - 3


PERCENTILE
1 10 20 30 40 50 60 70 80 90 99
1
2
3
4
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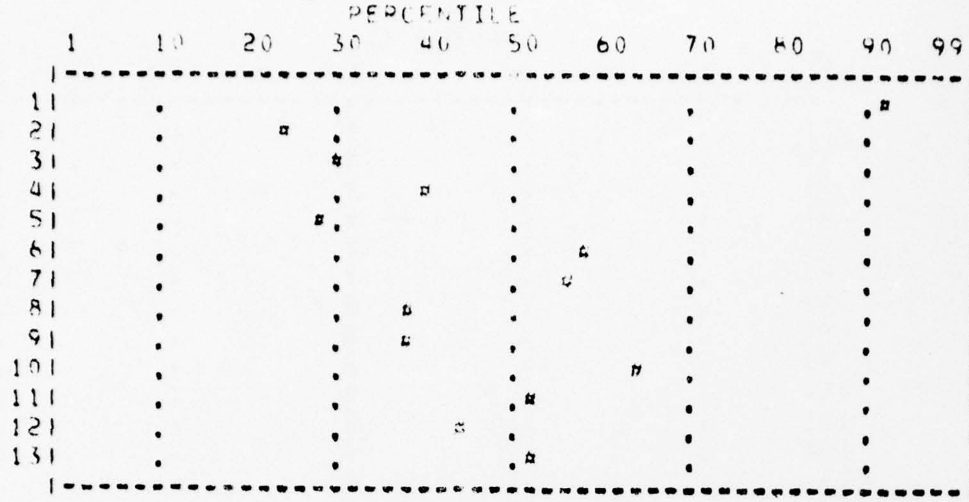
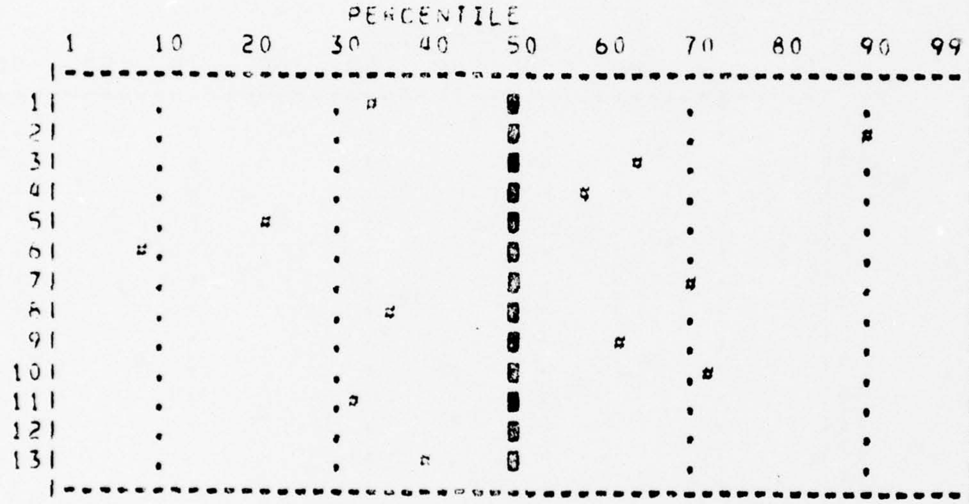
12
13

Figure 1 (Cont.)

C - 4



C - 5



C - 6

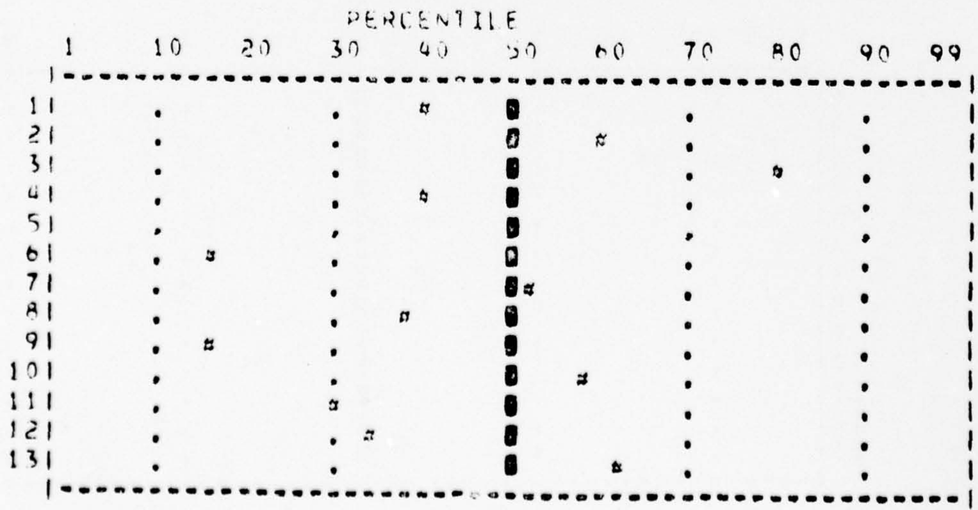
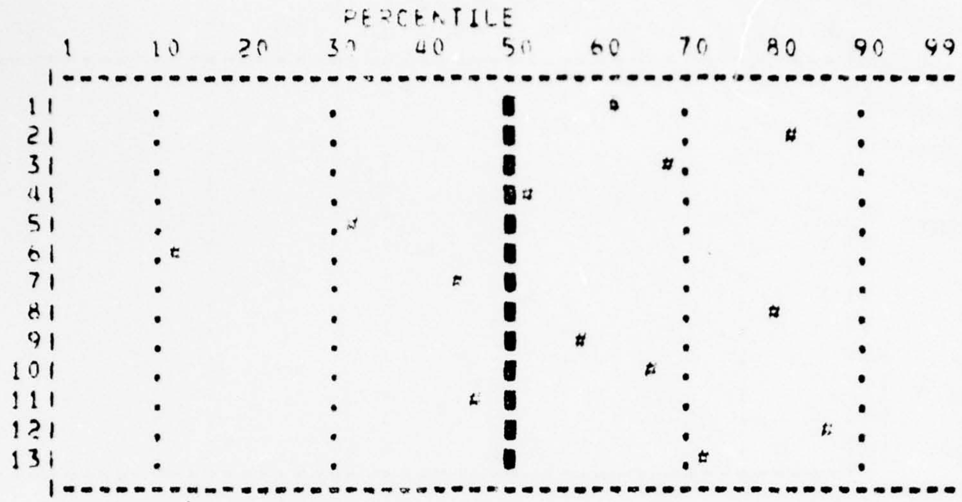
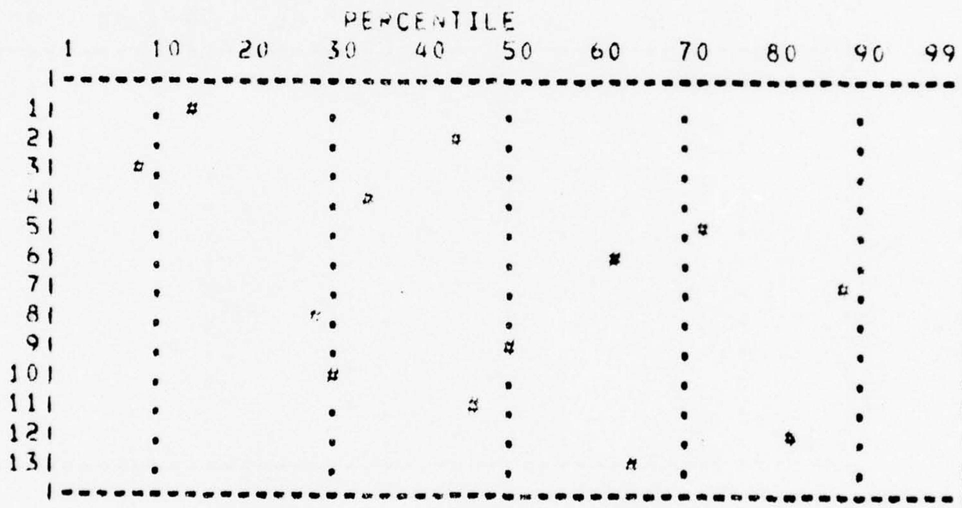


Figure 1 (Cont.)

C - 7



C - 8



C - 9

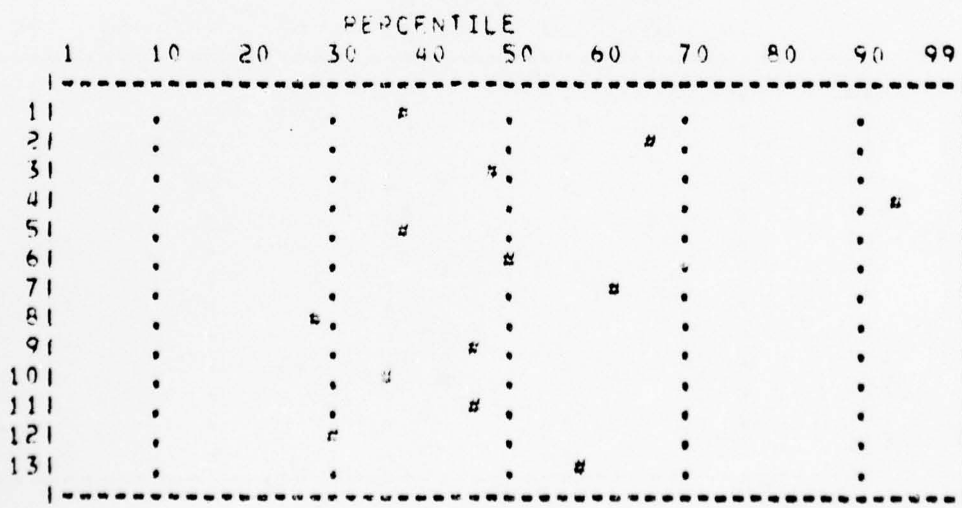
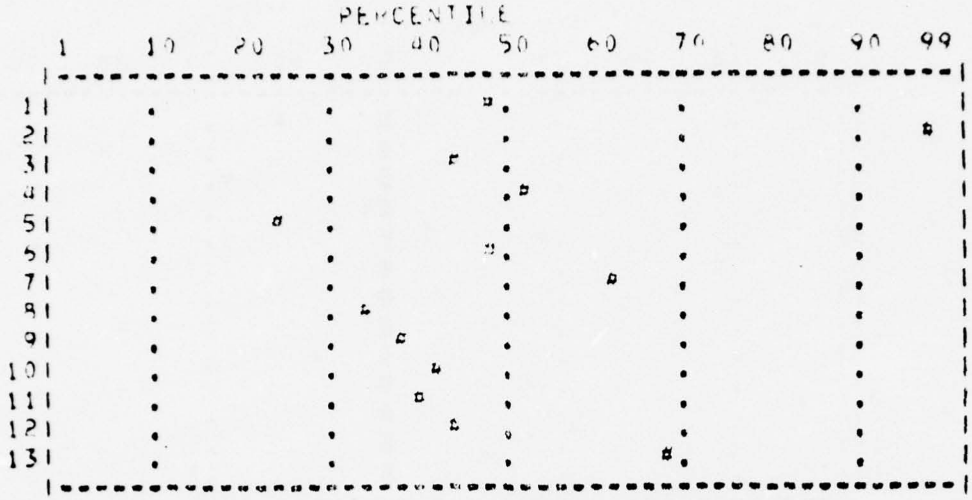
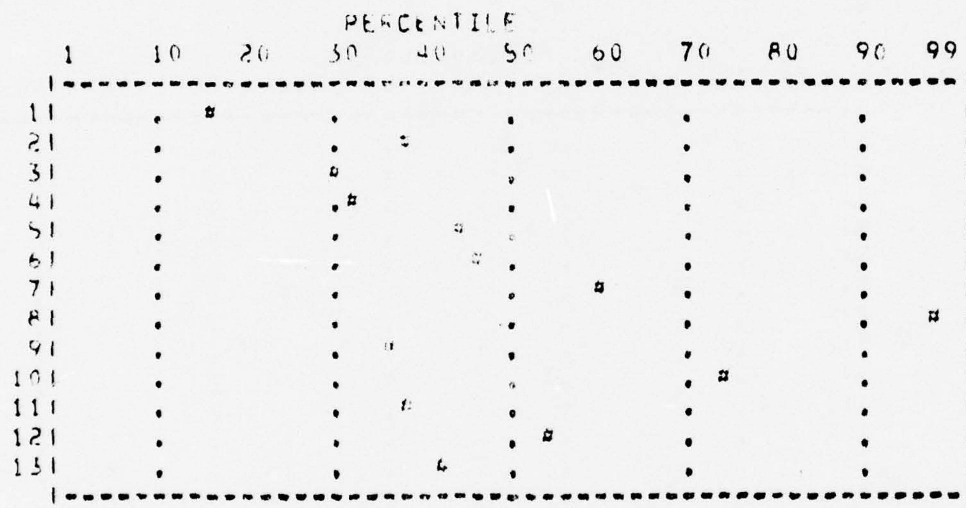


Figure 1 (Cont.)

C - 10



C - 11



C - 12

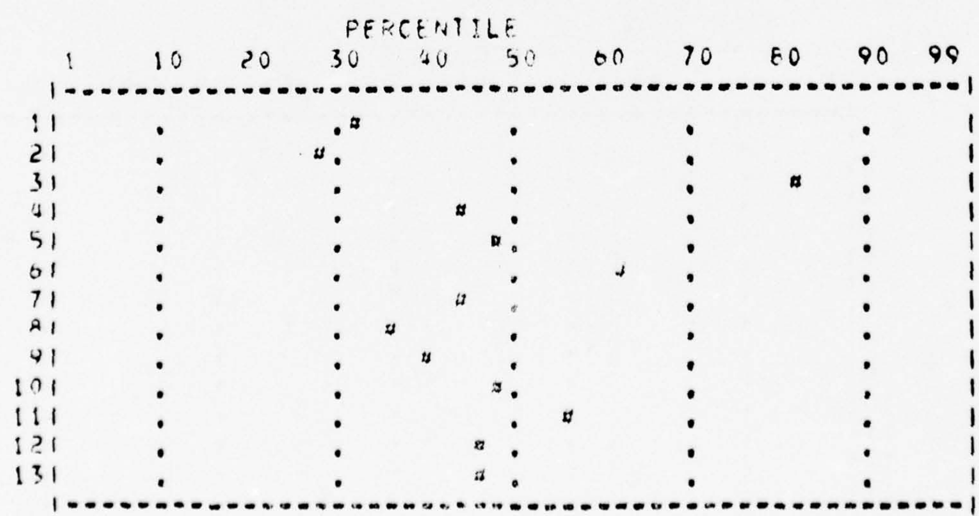
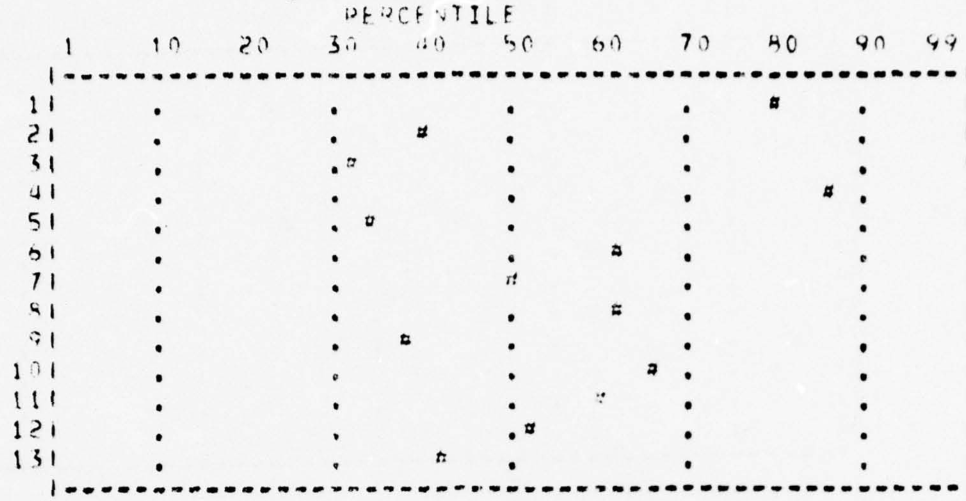
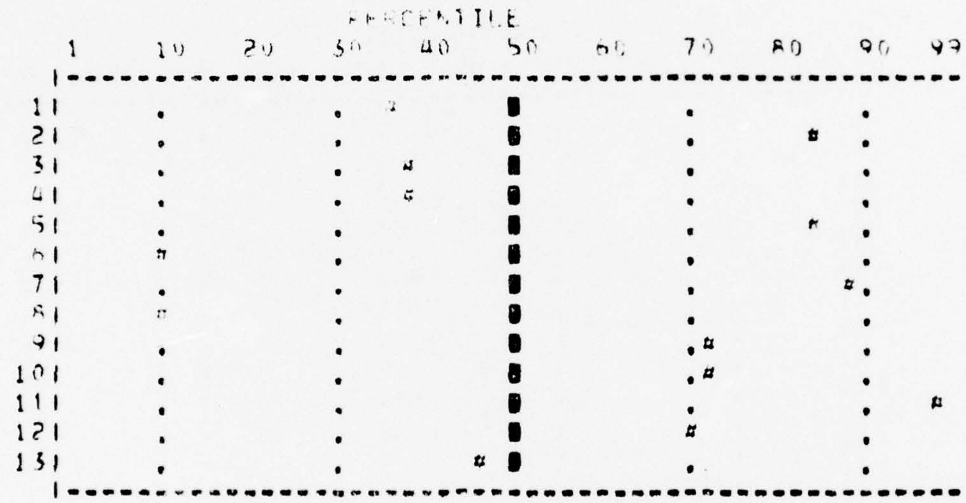


Figure 1 (Cont.)

C - 13



C - 14



C - 15

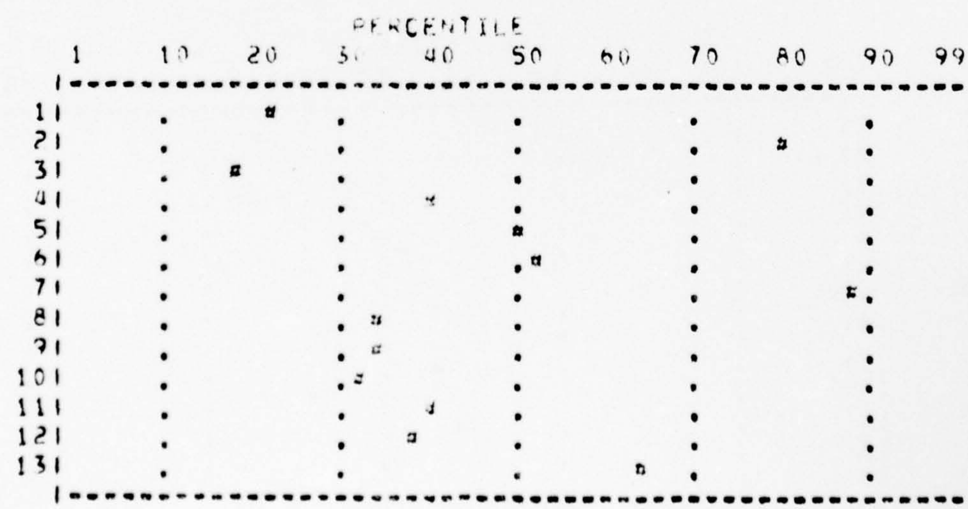
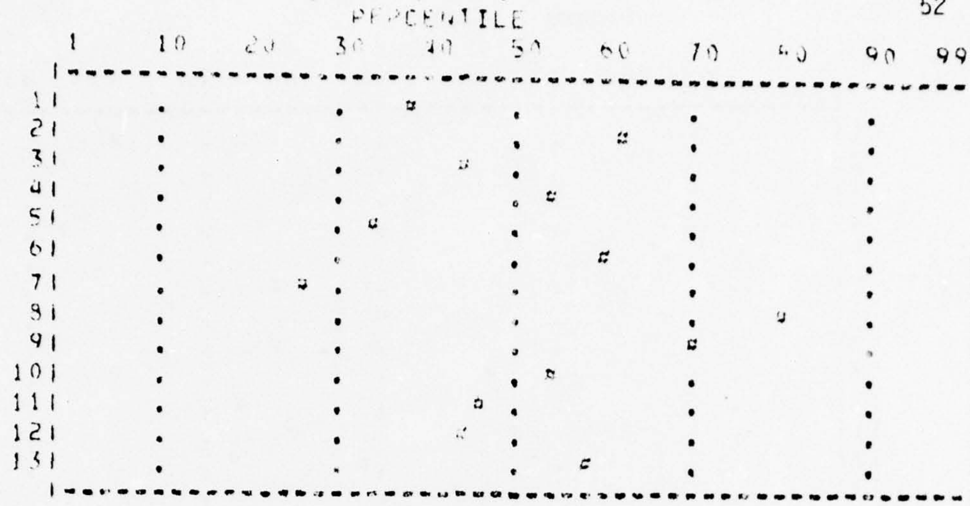
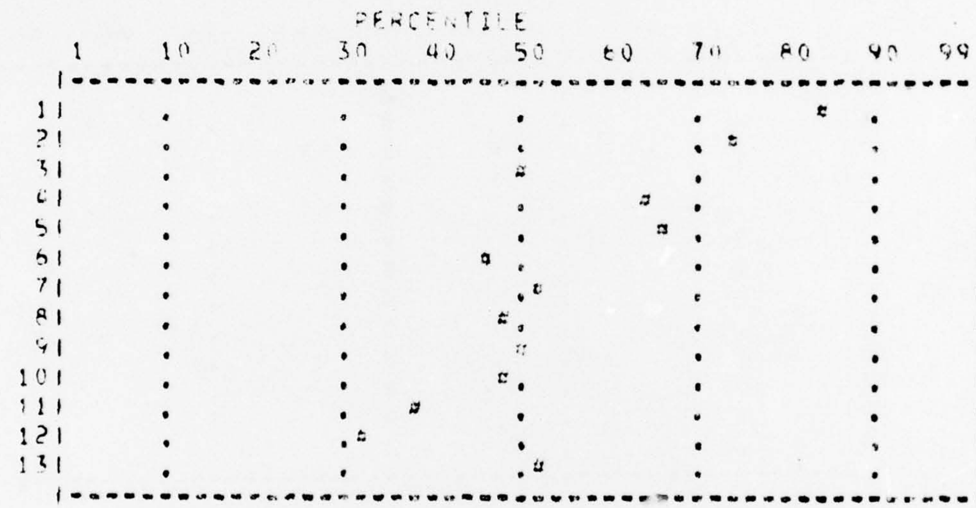


Figure 1 (Cont.)

C - 16



C - 17



C - 18

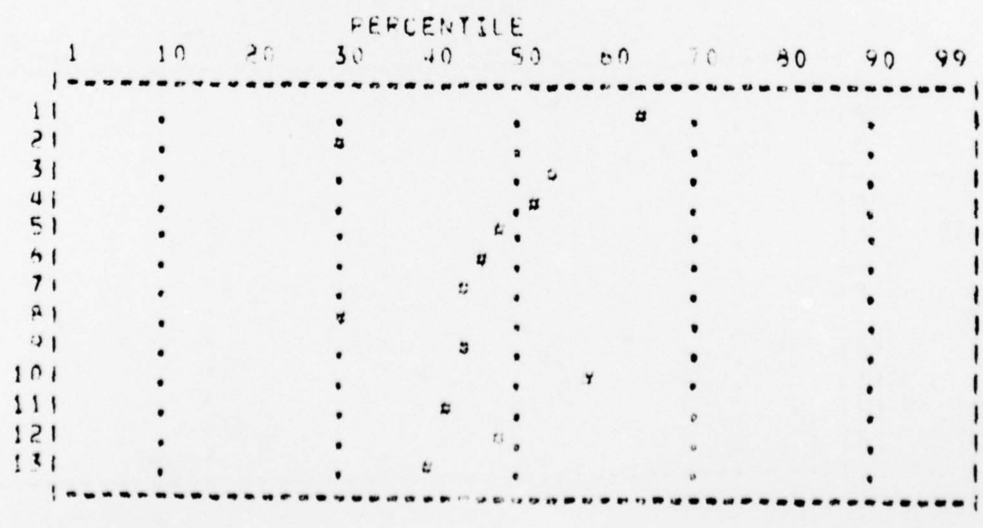
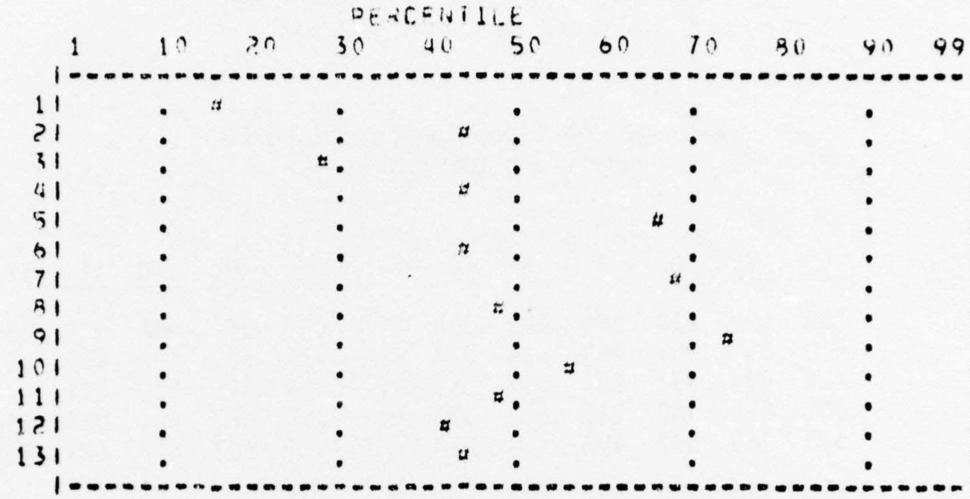


Figure 1 (Cont.)

C - 19



C - 20

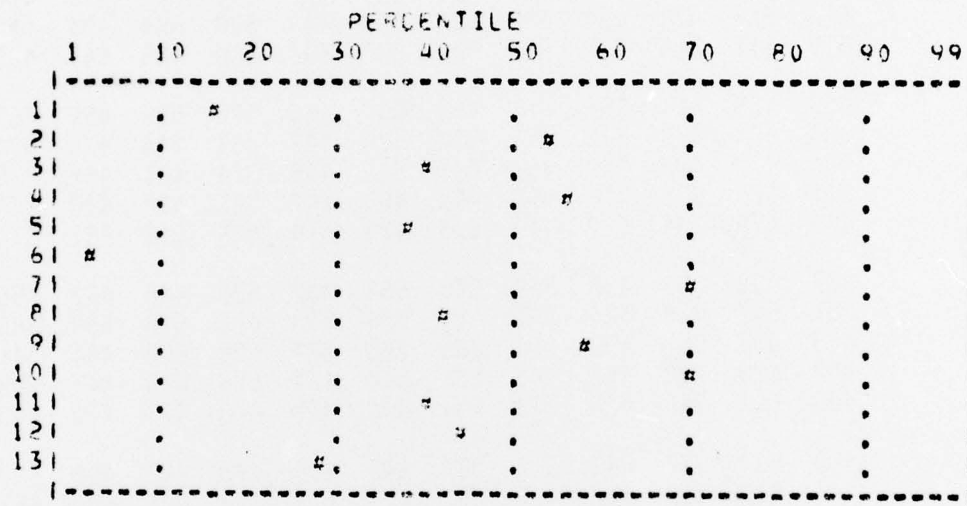


Table 2

Average Job Dimension Scores on 13 Overall Job Dimensions for Jobs in Each Cluster in Each of the Three Sets of Clusters.

Average Job Dimension Scores on 13 Overall Job Dimensions

Cluster Identification	1	2	3	4	5	6	7	8	9	10	11	12	13
A - 1	589	503	514	585	493	324	575	66	259	442	335	658	556
A - 2	420	591	461	343	614	527	822	456	523	505	468	556	558
A - 3	427	633	497	431	549	561	752	546	315	450	521	424	581
A - 4	601	653q	482	385	613	310	611	288	689	661	935	490	513
A - 5	530	365	572	498	414	548	548	571	602	477	637	452	529
A - 6	582	443	417	525	480	485	528	534	424	499	832	498	544
A - 7	485	509	464	542	563	406	464	453	553	500	436	449	411
A - 8	382	399	502	520	526	522	600	467	596	475	471	496	601
A - 9	523	667	474	424	428	526	583	444	570	584	434	446	625
A - 10	619	511	535	471	587	520	537	592	500	425	447	425	439
A - 11	450	558	561	456	511	482	552	446	420	516	459	461	571
A - 12	434	624	423	510	442	500	598	447	451	445	470	434	543
A - 13	466	737	422	580	358	453	513	446	374	401	462	376	564
A - 14	511	578	535	476	498	448	463	647	547	421	490	634	504
A - 15	441	579	544	527	443	523	423	614	535	511	481	474	574
A - 16	377	433	351	488	579	526	583	432	535	448	472	596	528
A - 17	391	547	428	524	591	421	364	538	478	549	553	385	461
A - 18	465	596	557	493	414	286	560	484	529	600	444	541	469
A - 19	448	529	392	457	440	568	564	424	628	418	447	688	429
A - 20	408	552	346	475	512	451	606	453	478	477	473	440	497
A - 21	400	517	372	443	541	538	642	448	478	447	498	582	538
A - 22	440	480	429	465	485	552	421	619	613	496	480	551	506
A - 23	553	589	476	534	669	520	449	557	522	439	619	428	498
A - 24	405	519	444	478	478	467	665	516	547	526	450	471	395
A - 25	449	499	493	617	471	478	552	440	516	492	487	491	511
A - 26	391	502	435	496	567	464	557	437	561	489	515	479	495
A - 27	603	471	457	703	460	553	474	481	426	540	499	523	481
A - 28	445	425	588	573	466	408	465	501	540	482	545	475	469
A - 29	390	460	567	576	527	284	537	422	580	489	566	497	483
A - 30	473	632	482	536	395	534	516	470	578	453	469	523	476
A - 31	424	533	418	615	498	575	444	458	602	456	524	542	458
A - 32	522	427	473	478	534	351	550	493	529	518	433	565	497
A - 33	451	648	518	538	522	399	548	446	537	526	459	471	479
A - 34	398	454	429	458	573	511	450	513	598	530	513	494	519
A - 35	497	572	474	481	440	517	411	532	561	546	485	476	520
A - 36	554	727	548	505	389	488	490	490	489	462	503	554	578
A - 37	641	523	431	575	739	558	475	458	509	535	262	473	518
A - 38	420	439	466	475	504	467	522	775	447	509	490	460	536
A - 39	422	594	418	469	465	486	584	457	530	465	469	532	489
A - 40	493	505	596	418	488	352	469	486	399	523	429	458	501

Table 2 (cont.)

Average Job Dimension Scores on 13
Overall Job Dimensions

Cluster Identification	1	2	3	4	5	6	7	8	9	10	11	12	13
A - 41	492	577	498	637	473	525	508	441	463	432	491	405	521
A - 42	409	541	489	513	446	270	560	478	531	567	445	465	393
A - 43	451	450	593	465	508	540	485	448	449	498	495	491	480
A - 44	468	644	509	512	492	528	451	541	559	514	494	586	465
A - 45	567	482	454	549	455	525	515	562	506	545	484	494	467
A - 46	637	505	533	470	555	409	500	641	482	461	492	597	490
A - 47	414	532	475	451	457	558	547	749	498	626	472	460	478
A - 48	565	556	504	562	448	465	481	466	493	508	441	444	531
A - 49	661	419	423	503	443	533	519	504	449	513	520	481	490
A - 50	486	500	517	567	456	510	469	609	594	474	492	439	491
A - 51	678	632	454	533	554	373	444	459	406	398	326	476	591
A - 52	545	602	556	530	421	332	500	525	502	560	483	595	596
A - 53	543	441	519	508	455	524	476	438	469	523	489	490	472
A - 54	474	689	476	502	453	505	539	454	462	474	477	489	516
A - 55	622	438	460	458	439	520	512	451	477	551	489	482	514
A - 56	617	578	545	501	543	527	609	468	547	589	630	513	467
A - 57	382	441	410	445	491	453	515	679	443	544	461	586	469
A - 58	427	588	469	487	595	400	609	393	526	533	733	567	487
A - 59	394	457	379	491	496	283	526	504	460	550	509	534	546
A - 60	412	549	405	486	521	546	503	456	416	434	477	464	567
B - 1	501	653	482	385	613	310	611	288	689	661	935	490	513
B - 2	582	443	417	525	400	485	528	534	424	499	832	498	544
B - 3	377	438	351	483	579	526	583	432	535	448	472	596	528
B - 4	400	517	372	443	541	538	642	448	478	447	498	582	538
B - 5	440	480	429	466	485	552	421	619	613	497	480	551	506
B - 6	405	519	444	478	475	467	665	516	547	526	450	471	395
B - 7	449	499	493	617	471	478	552	440	516	492	487	491	511
B - 8	603	471	457	703	460	553	474	481	426	540	499	523	481
B - 9	390	460	567	576	527	284	537	422	480	489	566	497	483
B - 10	497	572	474	481	440	517	411	532	561	546	485	476	520
B - 11	554	727	548	505	389	488	490	490	489	462	503	554	578
B - 12	492	577	493	687	473	525	508	441	463	432	491	405	521
B - 13	409	541	589	513	446	270	560	478	531	567	445	465	393
B - 14	451	450	593	465	508	540	485	448	449	498	495	491	480
B - 15	567	482	454	549	455	525	515	562	506	545	484	494	467
B - 16	565	556	504	562	448	465	481	466	493	508	441	444	531
B - 17	543	441	519	508	455	524	476	438	469	523	489	490	472
B - 18	617	578	545	501	543	527	609	468	547	589	630	513	467
B - 19	382	441	410	445	491	453	515	679	443	544	461	586	469
B - 20	427	583	469	487	595	400	609	393	526	533	733	567	487

Table 2 (cont.)

Average Job Dimension Scores on 13
Overall Job Dimensions

Cluster Identification	1	2	3	4	5	6	7	8	9	10	11	12	13
B - 21	394	457	379	491	497	283	526	504	460	550	509	534	546
B - 22	629	504	527	486	570	389	512	646	444	459	568	603	506
B - 23	466	409	585	554	457	519	484	520	554	483	569	472	475
B - 24	470	525	528	550	450	523	455	613	515	484	487	454	519
B - 25	471	635	492	526	395	534	439	499	572	476	478	608	481
B - 26	432	532	410	560	480	575	486	446	610	441	496	597	448
B - 27	636	431	450	473	442	522	508	469	471	540	498	482	508
B - 28	409	549	387	480	520	411	604	458	435	446	477	452	544
B - 29	457	626	534	522	420	348	551	461	533	554	454	499	475
B - 30	588	544	508	502	623	523	499	576	508	430	522	430	470
B - 31	503	460	468	508	590	379	515	478	542	512	432	514	457
B - 32	427	608	422	492	453	493	588	453	494	453	470	482	518
B - 33	391	511	431	502	569	444	515	460	539	500	533	458	492
B - 34	418	487	472	462	477	510	532	760	474	572	466	462	484
B - 35	660	585	442	553	634	456	455	460	450	450	291	469	564
B - 36	394	440	448	474	559	508	489	499	597	513	503	495	543
B - 37	423	610	475	382	567	543	792	496	428	480	486	499	566
B - 38	477	526	581	472	498	408	503	473	404	524	439	457	531
B - 39	479	693	467	503	436	501	545	451	463	481	469	465	533
B - 40	531	591	546	506	453	384	483	581	522	545	492	613	559
C - 1	629	504	527	486	570	389	512	646	444	459	468	603	506
C - 2	471	635	492	526	395	534	489	499	572	476	478	608	481
C - 3	432	532	410	560	480	474	486	446	610	441	496	597	448
C - 4	636	431	450	473	442	522	508	469	471	540	498	482	508
C - 5	457	626	534	522	420	348	551	461	533	554	454	499	475
C - 6	477	526	581	472	498	408	503	473	404	524	439	457	531
C - 7	531	591	546	506	453	384	483	481	522	545	492	613	559
C - 8	390	485	364	459	551	524	618	440	496	448	492	591	542
C - 9	471	539	494	549	473	505	532	442	489	460	490	446	517
C - 10	494	699	484	504	424	493	531	458	471	480	475	481	548
C - 11	404	469	447	455	483	493	527	727	463	562	461	511	481
C - 12	455	439	591	485	495	536	484	463	480	498	509	488	482
C - 13	582	475	452	502	460	534	501	528	466	538	532	507	484
C - 14	463	600	474	470	603	377	610	369	561	561	779	555	487
C - 15	419	582	411	475	496	508	620	458	560	453	477	470	533
C - 16	471	530	486	509	454	524	433	587	553	409	488	484	514
C - 17	597	563	500	533	543	485	401	494	497	493	473	453	509
C - 18	536	444	508	507	494	494	486	449	489	522	476	496	472
C - 19	390	488	442	484	511	484	549	493	565	516	490	476	483
C - 20	404	513	473	514	471	275	548	478	520	552	465	484	439

Table 3

Mean Square Error for Each Set
of Clusters and for Each
Cluster Separately Within Each Set

Set A - 60 Clusters: ms error for Set A = 87.764

ms error for Each Cluster Within Set A

Cluster	Corresponding clusters in other sets	ms error	Cluster	Corresponding clusters in other sets	ms error
A - 1	x	37.029	A - 31	x	118.484
A - 2	x	33.757	A - 32	x	154.542
A - 3	x	53.939	A - 33	x	88.716
A - 4	B - 1	112.967	A - 34	x	85.187
A - 5	x	77.345	A - 35	B - 10	99.352
A - 6	B - 2	103.789	A - 36	B - 11	133.706
A - 7	x	94.355	A - 37	x	197.217
A - 8	x	59.479	A - 38	x	115.675
A - 9	x	83.519	A - 39	x	72.449
A - 10	x	85.819	A - 40	x	124.210
A - 11	x	59.513	A - 41	B - 12	100.770
A - 12	x	44.946	A - 42	B - 13	57.369
A - 13	x	92.450	A - 43	B - 14	43.725
A - 14	x	90.546	A - 44	x	94.231
A - 15	x	105.690	A - 45	B - 15	93.172
A - 16	B - 3	63.516	A - 46	x	126.671
A - 17	x	128.240	A - 47	x	134.055
A - 18	x	81.258	A - 48	B - 16	113.304
A - 19	x	119.206	A - 49	x	82.979
A - 20	x	66.965	A - 50	x	104.390
A - 21	B - 4	75.005	A - 51	x	312.537
A - 22	B - 5	85.503	A - 52	x	145.343
A - 23	x	130.158	A - 53	B - 17	68.200
A - 24	B - 6	73.215	A - 54	x	103.379
A - 25	B - 7	74.269	A - 55	x	75.706
A - 26	x	83.106	A - 56	B - 18	176.410
A - 27	B - 8	83.922	A - 57	B - 19	183.141
A - 28	x	103.121	A - 58	B - 20	172.717
A - 29	B - 9	112.837	A - 59	B - 21	165.270
A - 30	x	51.331	A - 60	x	62.558

Table 3 (cont.)

Set B - 40 Clusters: ms error for Set B = 101.736

ms error for Each Cluster Within Set B

Cluster	Corresponding clusters in other sets	ms error	Cluster	Corresponding clusters in other sets	ms error
B - 1	A - 4	112.987	B - 21	A -59	165.270
B - 2	A - 5	119.174	B - 22	C - 1	152.641
B - 3	A - 6	63.516	B - 23	x	135.530
B - 4	A - 21	75.005	B - 24	x	125.210
B - 5	A - 22	85.503	B - 25	C - 2	77.942
B - 6	A - 24	73.215	B - 26	C - 3	149.970
B - 7	A - 25	74.269	B - 27	C - 4	89.789
B - 8	A - 27	83.922	B - 28	x	75.929
B - 9	A - 29	112.837	B - 29	C - 5	106.997
B - 10	A - 35	99.352	B - 30	x	152.828
B - 11	A - 36	197.217	B - 31	x	171.383
B - 12	A - 41	100.770	B - 32	x	73.514
B - 13	A - 42	57.369	B - 33	x	122.141
B - 14	A - 43	43.725	B - 34	x	155.987
B - 15	A - 45	93.172	B - 35	x	325.040
B - 16	A - 48	113.304	B - 36	x	100.538
B - 17	A - 53	68.200	B - 37	x	117.302
B - 18	A - 56	176.400	B - 38	C - 6	128.348
B - 19	A - 57	183.141	B - 39	x	130.270
B - 20	A - 58	172.717	B - 40	C - 7	166.999

Set C - 20 Clusters: ms error for Set C = 129.326

ms error for Each Cluster Within Set C

Cluster	Corresponding Clusters in other sets	ms error	Cluster	Corresponding clusters in other sets	ms error
C - 1	B - 22	152.641	C - 11	x	197.238
C - 2	B - 25	77.942	C - 12	x	80.262
C - 3	B - 26	149.970	C - 13	x	133.184
C - 4	B - 27	89.789	C - 14	x	262.663
C - 5	B - 29	106.997	C - 15	x	105.075
C - 6	B - 38	128.348	C - 16	x	148.725
C - 7	B - 40	166.999	C - 17	x	242.810
C - 8	x	90.197	C - 18	x	118.300
C - 9	x	117.572	C - 19	x	136.106
C - 10	x	152.355	C - 20	x	130.271

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